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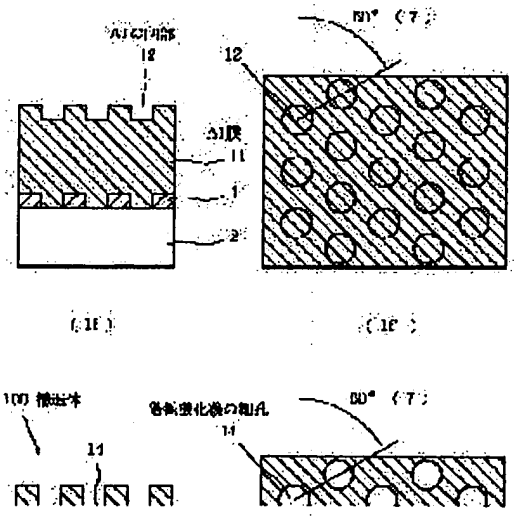
(54) MANUFACTURING METHOD FOR STRUCTURE HAVING SMALL HOLES, STRUCTURE MANUFACTURED BY THE METHOD, AND STRUCTURE DEVICE USING THE STRUCTURE

(57)Abstract:

PROBLEM TO BE SOLVED: To establish a nano-structure manufacturing method capable of forming thin holes in cylindrical shape arranged at any cyclic period on a base over a large area easily at a low cost in a short time.

SOLUTION: The manufacturing method for a structure having thin holes comprises a process to prepare a base board 2 having recesses at the surface, a process to form a film 11 as work to be processed on the surface of the board, and a process to subject the film as work to be processed to a positive electrode oxidation.



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* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] (1) the process which prepares for a front face the substrate which has a crevice, and (2) -- the process which arranges the workpiece film on said substrate front face, and (3) -- the manufacture approach of the structure which has the pore characterized by having the process which anodizes said workpiece film.
[Claim 2] It is the manufacture approach of the structure according to claim 1 which the substrate which has a crevice on said front face has the (a) 1st layer, the conductive layer arranged on the layer of the (b) above 1st, and the 2nd layer arranged on the (c) aforementioned conductive layer, and is characterized by said 2nd layer having the through tube which said conductive layer exposes to the part.
[Claim 3] It is the manufacture approach of the structure according to claim 1 characterized by being arranged so that the substrate which has a crevice on said front face may have the (a) 1st layer, the conductive layer arranged on the layer of the (b) above 1st, and the 2nd layer arranged on the (c) aforementioned conductive layer and said a part of conductive layer may expose said 2nd layer.
[Claim 4] The conductivity of said 2nd layer is the manufacture approach of the structure according to claim 2 or 3 characterized by being lower than the conductivity of said conductive layer.
[Claim 5] Said 2nd layer is the manufacture approach of the structure according to claim 4 characterized by consisting of an insulating ingredient.
[Claim 6] The process which arranges the ingredient with which the process for arranging said 2nd layer should serve as said 2nd layer on the (a) aforementioned conductive layer, (b) the process which gives an interference exposure process twice or more to the ingredient which should serve as said 2nd layer, and interference exposure of the 2nd layer of (c) above were exposed, or by removing some or all of a field that was not exposed The manufacture approach of the structure according to claim 2 to 5 characterized by having the process at which said a part of conductive layer is exposed, and the direction of an interference fringe in the interference exposure process of the 2nd henceforth differing from the direction of an interference fringe in the 1st interference exposure process in said interference exposure process.
[Claim 7] The process which arranges the ingredient layer from which the process for arranging said 2nd layer should serve as said 2nd layer on the (a) aforementioned conductive layer, (b) The process which arranges a sacrifice layer on the ingredient layer which should turn into said 2nd layer, (c) The process which gives an interference exposure process twice or more to said sacrifice layer, and interference exposure of the (d) aforementioned sacrifice layer were exposed. Or the process at which a part of ingredient layer which should remove some or all of a field that was not exposed and should turn into said 2nd layer is exposed, (e) Remove the ingredient layer which should turn into said 2nd exposed layer, and have the process at which said a part of conductive layer is exposed, and it sets at said interference exposure process. The manufacture approach of the structure according to claim 2 to 5 characterized by the direction of an interference fringe in the interference exposure process of the 2nd henceforth differing from the direction of an interference fringe in the 1st interference exposure process.
[Claim 8] The process which prepares for said front face the substrate which has a crevice is the manufacture approach of the structure according to claim 1 characterized by including the process which removes a part of substrate front face.
[Claim 9] The process which prepares for said front face the substrate which has a crevice is the manufacture approach of the structure according to claim 8 characterized by the thing also including the process which arranges the

conductive film on the substrate from which said a part of front face was removed further to do.
[Claim 10] Said substrate is the manufacture approach of the structure according to claim 8 or 9 characterized by being conductivity.
[Claim 11] The process which removes said a part of substrate front face is the manufacture approach of the structure according to claim 8 to 10 characterized by being carried out by irradiating a focused ion beam.
[Claim 12] It is the manufacture approach of the structure according to claim 1 which the substrate which has a crevice on said front face has the (a) 1st layer, and the 2nd layer arranged on the front face of the 1st layer of (b) above, and is characterized by said 2nd layer having the through tube which said 1st layer exposes to the part.
[Claim 13] It is the manufacture approach of the structure according to claim 1 characterized by being arranged so that the substrate which has a crevice on said front face may have the (a) 1st layer, and the 2nd layer arranged on the layer of the (b) above 1st and said a part of 1st layer may expose said 2nd layer.
[Claim 14] Said 1st layer is the manufacture approach of the structure according to claim 12 or 13 characterized by being a conductor or a semi-conductor.
[Claim 15] The conductivity of said 2nd layer is the manufacture approach of the structure according to claim 12 to 14 characterized by being lower than the conductivity of said 1st layer.
[Claim 16] Said 2nd layer is the manufacture approach of the structure according to claim 12 to 15 characterized by consisting of an insulating ingredient.
[Claim 17] The process which arranges the ingredient with which the process for arranging said 2nd layer should serve as said 2nd layer on the layer of the (a) above 1st, (b) The process which gives an interference exposure process twice or more to the ingredient which should serve as said 2nd layer, (c) Have the process at which said 1st layer is exposed by said interference exposure having been exposed or removing some or all of a field that was not exposed, and it sets at said interference exposure process. The manufacture approach of the structure according to claim 12 to 16 characterized by differing from the direction of an interference fringe in the interference exposure process that the direction of an interference fringe in the interference exposure process of the 2nd henceforth is the 1st time.
[Claim 18] The process which arranges the ingredient layer from which the process for arranging said 2nd layer should serve as said 2nd layer on the layer of the (a) above 1st, (b) The process which arranges a sacrifice layer on the ingredient layer which should turn into said 2nd layer, (c) The interference exposure of a process and the (d) aforementioned sacrifice layer which gives an interference exposure process twice or more was exposed to said sacrifice layer. Or the process at which a part of ingredient layer which should remove some or all of a field that was not exposed and should turn into said 2nd layer is exposed, (e) Remove the ingredient layer which should turn into said 2nd exposed layer, and have the process at which said a part of 1st layer is exposed, and it sets at said interference exposure process. claim 12 characterized by the direction of an interference fringe in the interference exposure process of the 2nd henceforth differing from the direction of an interference fringe in the 1st interference exposure process thru/or 16 -- the manufacture approach of the structure given in either.
[Claim 19] The process which prepares for said front face the substrate which has a crevice is the manufacture approach of the structure according to claim 12 to 16 characterized by including the process which arranges the member which should serve as said 2nd layer on said 1st layer, and the process at which it is removing a part of member which should serve as said 2nd layer, and said a part of 1st layer is exposed.
[Claim 20] The process which removes said a part of 2nd layer is the manufacture approach of the structure according to claim 19 characterized by being carried out by irradiating a focused ion beam.
[Claim 21] The structure characterized by being manufactured by the manufacture approach according to claim 1 to 20.

[Claim 22] The structure device using the structure according to claim 21.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the minute structure and the minute structure device which are manufactured by the minute manufacture approach of the structure, and the list by this manufacture approach. It is related with the approach of manufacturing the regulation-ized minute structure, by producing a concavo-convex pattern on a base front face and a base using interference exposure, a focused ion beam exposure, etc. especially. Moreover, it is related with the microstructure device characterized by using a regular microstructure as mold or a mask.
[0002]
[Description of the Prior Art] In a metal and the thin film of a semi-conductor, a thin line, and a dot, in size smaller than a certain characteristic die length, a motion of an electron is shut up, consequently there is a unique thing for which electric, optical, and chemical property are shown. The interest about the microstructure (it is also called the nano structure) of nano size which has structure more detailed than several 100nm as high-performance material from such a viewpoint is increasing.
[0003] As the production approach of such the nano structure, photolithography is begun and the approach of producing the nano structure directly with semi-conductor processing techniques, such as electron beam lithography and X-ray lithography, is mentioned, for example. The formation approach of a detailed pattern is for example, M.C.Hutley, "Coherent Photofabrication", and Optical. Engineering, Vol.15, No.3 (1976), J. Y.Decker et al, "Generation of subquarter-micron resist structures usingoptical interference lithography and image It is reported to reversal", J.Vac.Sci.Technol, Bl5 (6), and Nov/Dec (1997).
[0004] Moreover, the attempt which is going to realize the new nano structure is in the base in the regular structure formed automatically, i.e., the structure formed in a self-regulation target, besides such a production approach.
[0005] The anode oxidation method which can produce easily the structure which has the hole (nano hole) of nano size with sufficient control as such self-regular technique is mentioned. For example, the anodic oxidation alumina which produces aluminum and its alloy by anodizing in an acid bath is known.
[0006] If aluminum plate is anodized in an acid electrolyte, a porosity oxide film will be formed (for example, reference, such as R, C.Furneaux, "The formation of controlled-porosity membranes from anodically oxidlzed aluminium", and NATURE, Vol.337, Pl47 (1989)). The very detailed cylindrical pore (nano hole) whose diameter is several nm - hundreds of nm has the description of this porosity oxide film in having the specific geometric structure of arranging at intervals of several nm - hundreds of nm (cell size).
[0007] Moreover, in order to improve the perpendicularity, the linearity, and the independence of said pore, the method of performing two steps of anodic oxidation is proposed. Once this approach removes the porosity oxide film anodized and formed, it anodizes again. It is what produces the porosity oxide film which has pore. It is (). [Masuda] et al and "Fabrication of gold nanodot array using anodic porous alumina as an evaporationmask", Jpn.J.Appl.Phys, Vol.35 and Part2, No.lB, Ll26-Ll29 (1996).
[0008] Furthermore, it is aluminum in the approach of using a stamper and forming the formation start point of pore, in order to improve the controllability of the configuration of the pore of a porosity oxide film, spacing, and a pattern, i.e., the substrate which equipped the front face with two or more projections. It anodizes, after pushing on the surface of a

plate and forming the made hollow as a formation start point of pore, and the approach of producing the porosity oxide film which has pore is also proposed (JP,10-121292,A). Moreover, JP,11-200090,A, an EP-A -0913850 [No.] official report, an EP-A -0951047 [No.] official report, etc. have the indication about the porosity oxide skin which has pore.
[0009] Various application which paid its attention to the specific geometrical structure of this anodic oxidation alumina is tried. For example, the application and the coat as a coat using the abrasion resistance of an oxide film on anode and insulation-proof are exfoliated, and there is application to a filter. Furthermore, various application including coloring, a magnetic-recording medium, EL light emitting device, an electrochromic element, an optical element, a solar battery, and a gas sensor is tried from using the technique filled up with a metal, a semi-conductor, etc. in a nano hole, and the replica technique of a nano hole. Furthermore, the application to the directions of many, such as the quantum effectiveness devices, such as quantum wire and an MIM component, and a molecule sensor using a nano hole as a chemical reaction place, is expected. (Takanori rule nature metal nano hole array" based on the Masuda" anodic oxidation alumina, "solid-state physics", Vol.31, No.5,493-499 (1996))
[0010]
[Problem(s) to be Solved by the Invention] Direct production of the structure of nano size by the semi-conductor processing technique expressed previously has problems, like the badness of the yield and the cost of equipment are high, and technique producible with sufficient repeatability by simple technique is desired.
[0011] From such a viewpoint, in case the self-regular technique, especially the technique of anodic oxidation produce the structure with minute nano size with sufficient control easily and produce the nano structure to a large area, they attract attention.
[0012] However, by the technique by the usual anodic oxidation, although the configuration of the pore (nano hole) formed and many techniques which control a pattern were developed, there was a limitation in the controllability.
[0013] Furthermore, the example which produced the regulation-ized nano hole which pore (nano hole) arranged in the shape of a honeycomb by anodizing under suitable anodic oxidation conditions by above-mentioned Masuda and others as an example which controlled the array of pore is reported. However, in this regulation-ized nano hole, there were technical problems, like there is a limit to be anodized [of long duration] in pore spacing which can be produced.
[0014] Then, the purpose of this invention is offering a technique producible in cheap, easy, and a short time for the pore arranged to arbitration over a large area in the manufacture approach of the structure (nano structure) which has the hole produced by anodic oxidation.
[0015] Furthermore, it is using as the base the structure which has the hole of the nano size produced with the application of these techniques, and making use possible for the structure which indicates the new structure and a device and has the hole of nano size in directions various as a functional material.
[0016]
[Means for Solving the Problem] the process to which invention of the first of this invention prepares for (1) front face the substrate which has a crevice and (2) -- the process which arranges the workpiece film on said substrate front face, and (3) -- it is the manufacture approach of the structure which has the pore characterized by having the process which anodizes said workpiece film. [namely,]
[0017] above-mentioned this invention -- moreover, the substrate which has a crevice on said front face -- the (a) 1st layer, and (b) -- the conductive layer arranged on said 1st layer, and (c) -- it is characterized by having the 2nd layer arranged on said conductive layer, and said 2nd layer having the through tube which said conductive layer exposes to the part.
[0018] above-mentioned this invention -- moreover, the substrate which has a crevice on said front face -- the (a) 1st layer, and (b) -- the conductive layer arranged on said 1st layer, and (c) -- it is characterized by being arranged so that it may have the 2nd layer arranged on said conductive layer and said a part of conductive layer may expose said 2nd layer.
[0019] Above-mentioned this invention is characterized by the conductivity of said 2nd layer being lower than the conductivity of said conductive layer again. Above-mentioned this invention is characterized by said 2nd layer consisting of an insulating ingredient again.
[0020] Above-mentioned this invention moreover, the process for arranging said 2nd layer (a) The process which arranges the ingredient which should serve as said 2nd layer on said conductive layer, (b) the process which gives an interference exposure process twice or more to the ingredient which should serve as said 2nd layer, and interference

exposure of the 2nd layer of (c) above were exposed, or by removing some or all of a field that was not exposed It is characterized by having the process at which said a part of conductive layer is exposed, and the direction of an interference fringe in the interference exposure process of the 2nd henceforth differing from the direction of an interference fringe in the 1st interference exposure process in said interference exposure process.
[0021] Above-mentioned this invention moreover, the process for arranging said 2nd layer (a) The process which arranges the ingredient layer which should turn into said 2nd layer on said conductive layer, (b) The process which arranges a sacrifice layer on the ingredient layer which should turn into said 2nd layer, (c) The process which gives an interference exposure process twice or more to said sacrifice layer, and interference exposure of the (d) aforementioned sacrifice layer were exposed. Or the process at which a part of ingredient layer which should remove some or all of a field that was not exposed and should turn into said 2nd layer is exposed, (e) It is characterized by removing the ingredient layer which should turn into said 2nd exposed layer, and having the process at which said a part of conductive layer is exposed, and the direction of an interference fringe in the interference exposure process of the 2nd henceforth differing from the direction of an interference fringe in the 1st interference exposure process in said interference exposure process.
[0022] The process to which above-mentioned this invention prepares for said front face the substrate which has a crevice again is characterized by including the process which removes a part of substrate front face. The process to which above-mentioned this invention prepares for said front face the substrate which has a crevice again is characterized by the thing also including the process which arranges the conductive film on the substrate from which said a part of front face was removed further to do.
[0023] Above-mentioned this invention is characterized by said substrate being conductivity again. The process from which above-mentioned this invention removes said a part of substrate front face again is characterized by being carried out by irradiating a focused ion beam. above-mentioned this invention -- moreover, the substrate which has a crevice on said front face -- the (a) 1st layer, and (b) -- it has the 2nd layer arranged on the front face of said 1st layer, and said 2nd layer is characterized by having the through tube which said 1st layer exposes to the part.
[0024] above-mentioned this invention -- moreover, the substrate which has a crevice on said front face -- the (a) 1st layer, and (b) -- it is characterized by being arranged so that it may have the 2nd layer arranged on said 1st layer and said a part of 1st layer may expose said 2nd layer. Above-mentioned this invention is characterized by said 1st layer being a conductor or a semi-conductor again.
[0025] Above-mentioned this invention is characterized by the conductivity of said 2nd layer being lower than the conductivity of said 1st layer again. Above-mentioned this invention is characterized by said 2nd layer consisting of an insulating ingredient again.
[0026] Above-mentioned this invention moreover, the process for arranging said 2nd layer (a) The process which arranges the ingredient which should serve as said 2nd layer on said 1st layer, (b) The process which gives an interference exposure process twice or more to the ingredient which should serve as said 2nd layer, (c) Have the process at which said 1st layer is exposed by said interference exposure having been exposed or removing some or all of a field that was not exposed, and it sets at said interference exposure process. The direction of an interference fringe in the interference exposure process of the 2nd henceforth is characterized by differing from the direction of an interference fringe in the interference exposure process which is the 1st time.
[0027] Above-mentioned this invention moreover, the process for arranging said 2nd layer (a) The process which arranges the ingredient layer which should turn into said 2nd layer on said 1st layer, b) The process which arranges a sacrifice layer on the ingredient layer which should turn into said 2nd layer, c) The interference exposure of a process and the (d) aforementioned sacrifice layer which gives an interference exposure process twice or more was exposed to said sacrifice layer. Or the process at which a part of ingredient layer which should remove some or all of a field that was not exposed and should turn into said 2nd layer is exposed, (e) It is characterized by removing the ingredient layer which should turn into said 2nd exposed layer, and having the process at which said a part of 1st layer is exposed, and the direction of an interference fringe in the interference exposure process of the 2nd henceforth differing from the direction of an interference fringe in the 1st interference exposure process in said interference exposure process.
[0028] The process to which above-mentioned this invention prepares for said front face the substrate which has a crevice again is characterized by including the process which arranges the member which should serve as said 2nd layer on said 1st layer, and the process at which it is removing a part of member which should serve as said 2nd layer,

and said a part of 1st layer is exposed. The process from which above-mentioned this invention removes said a part of 2nd layer again is characterized by being carried out by irradiating a focused ion beam.
[0029] Invention of the second of this invention is the structure characterized by being manufactured by the manufacture approach of the structure which has the above-mentioned pore. Invention of the third of this invention is the structure device which used the above-mentioned structure.
[0030] According to the manufacture approach of above-mentioned this invention, regular pore can be formed over a large area. Moreover, according to the manufacture approach of this invention, the crevice on a workpiece front face (formation start point of pore) is formed right above to the crevice of "the concavo-convex pattern" arranged on a substrate. For this reason, the pore which was excellent in linearity at the time of the pore (nano hole) formation by anodic oxidation can be formed. Hereafter, this invention is explained to a detail.
[0031]
[Embodiment of the Invention] Hereafter, an example of the manufacture approach of the structure of this invention is explained using drawing. The process which will prepare for A:front face the substrate which has a crevice (heights) if the manufacture approach of this invention is roughly divided, the process which arranges a workpiece (film which uses aluminum as a principal component) on a B:this substrate front face, and C: It has the process which forms pore by anodizing this workpiece (film which uses aluminum as a principal component).
[0032] For this reason, it explains in order of the above-mentioned A-C process below. And they are the process (1a) shown below - (1g) Above A and B, and the process which explains C each process to a detail more. And (1g) of - (1a) drawing 3 of drawing 1 is a drawing corresponding to above-mentioned process (1a) - (1g). (1g') of - (1a') drawing 3 of drawing 1 is a top view, and (1g) of - (1a) drawing 3 of drawing 1 is each sectional view.
[0033] A: the process which prepares "the substrate which has a crevice (heights) on a front face" -- here, explain the case where said crevice (heights) is formed by arranging a member (the 2nd layer) on a substrate (1st layer) front face as the formation approach of "the substrate which has a crevice (heights) on a front face." In addition, in this invention, by deleting the substrate front face other than the approach explained below, also when preparing "the substrate which has a crevice (heights) on a front face", it is contained with a natural thing.
[0034] (1a) Prepare the selection substrate (the 1st layer) 2 of a substrate (the 1st layer). the conductor which consists of semi-conductor substrates including an insulator substrate, silicon, and gallium arsenide including quartz glass, a metal, etc. as a substrate 2 in this invention -- a substrate can be used.
[0035] In addition, as said substrate, when an insulator substrate is used, it is required for the field which forms the workpiece film (film which uses aluminum as a principal component) mentioned later to form the conductive film used as the electrode at the time of anodic oxidation. In this case, "a substrate (the 1st layer)" points out the thing containing an insulating substrate and the conductive film. It is desirable that it is the film which consists of conductive ingredients, such as tin oxide which doped bulb metals, such as niobium, titanium, a tungsten, and a tantalum, platinum, copper, and a fluorine, as this conductive film. moreover, not only when the above-mentioned insulating substrate is used for the above-mentioned conductive film, but said semi-conductor substrate and a conductor -- also when a substrate is used, the conductive film may be arranged on the front face Also in this case, "a substrate (the 1st layer)" points out the thing containing a substrate and the conductive film.
[0036] As for the above-mentioned conductive film, it is desirable to arrange at least one or more layers. In addition, if there is no un-arranging in case pore is formed by anodizing the workpiece film (film which uses aluminum as a principal component) 11 mentioned later, the thickness of a substrate (the 1st layer), especially a mechanical strength, etc. will not be limited.
[0037] Moreover, if the substrate in which the film of bulb metals, such as Ti and Nb, was formed on the front face, or the thing whose substrate itself is a bulb metal is used as a substrate 2 ((1a) of drawing 1), in the process of the below-mentioned anodization, advance of pore can be stopped in the interface of the above-mentioned bulb metal and the workpiece film mentioned later. Consequently, since the homogeneity of the depth of pore can be raised, it is desirable.

[0038] Here, the example using Si substrate which has not been formed explains the conductive film as a substrate 2. Next, "the concavo-convex pattern" of a request configuration is formed in the front face of the substrate prepared at said process (1a).
[0039] So that the field (crevice) which the location of a request of the ** above-mentioned substrate front face (it is

the conductive film front face when the conductive film is arranged) exposes may be formed with "the concavo-convex pattern" in this invention When pointing out what has arranged the film (the 2nd layer, i.e., "heights") which has predetermined thickness alternatively, the thing in which the crevice was formed may be pointed out by deleting the above-mentioned substrate front face (it being the conductive film front face, when the conductive film is arranged) of the location of the ** aforementioned request. Furthermore, what has arranged the gestalt which combined the ** above-mentioned ** and **, i.e., the film which has predetermined thickness around the location of said request, (the 2nd layer, i.e., "heights"), deleted the substrate front face of the location of said request, and formed the crevice may be pointed out.

[0040] And as for the ingredient which constitutes the film (the 2nd layer) arranged on a substrate front face, in this invention, it is desirable in the gestalt of the above-mentioned ** and ** to have conductivity lower than the ingredient which constitutes said substrate front face (it is the conductive film front face when the conductive film is arranged). And as for the ingredient which constitutes further said film (the 2nd layer) arranged in a desired location in the gestalt of the above-mentioned ** and **, it is desirable that it is an insulating ingredient. The pore formed of the anodic oxidation process mentioned later can make it go to the field (for the field of the conductive ingredient which constitutes said substrate to be exposed) which is not covered with said film (the 2nd layer) by making it this appearance, without facing to said film (the 2nd layer). consequently, the pore excellent in linearity -- repeatability -- it can form highly.

[0041] Formation of "the concavo-convex pattern" in this invention can be formed by various approaches. For example, a concavo-convex pattern can be formed in a substrate front face using electron beam lithography, interference exposure, a focused ion beam spatter, etc. Here, an example for forming "the concavo-convex pattern" (the 2nd layer) of the gestalt of the above-mentioned ** is explained using interference exposure.

[0042] "The concavo-convex pattern" of the gestalt of the above-mentioned ** may be the approach of forming heights (the 2nd layer) by arranging the film the approach of forming by arranging heights (the 2nd layer) alternatively on said substrate front face, or on said substrate front face, and removing some of film concerned. moreover, a crevice is a circle configuration -- good -- it is better -- you may have the shape of the shape of a square, and Rhine. The bottom of a crevice is a gestalt in which a substrate front face is exposed to and the 2nd layer (heights) encloses the perimeter of the exposed field. However, said exposed field is completely surrounded by the 2nd layer, and things are not necessarily needed. That is, it may be made to carry out array formation of the Rhine-like 2nd layer (heights) at two or more real target. Thus, when forming the 2nd layer (heights) in the shape of Rhine, it is desirable to make thickness of each 2nd layer (heights) the same substantially.

[0043] As an example of the ingredient of the film used by facing for forming "the concavo-convex pattern" (the 2nd layer) of the gestalt of the aforementioned ** or **, although many things are mentioned, here explains a positive resist, negative resist, and the other approaches of forming using SiO2.

[0044] When facing and using for forming "the concavo-convex pattern" (the 2nd layer) of the gestalt of the aforementioned ** or **, as an example of the ingredient of the sacrifice layer, the ultraviolet-rays high resolution resist for photolithographies is desirable. As a gestalt of a resist, although a positive type, a negative mold, and other various gestalten are mentioned, here explains how to form using a positive resist.

[0045] As "a concavo-convex pattern" (especially array pattern of a crevice) of this invention, the shape of the shape of the shape of a honeycomb and a grid and a delta etc. is mentioned. Here, how to form "a concavo-convex pattern" in the shape of a honeycomb is explained. First, SiO2 film 1 used as the base material of "a concavo-convex pattern" (the 2nd layer) is formed on the Si substrate 2 prepared at the above mentioned process (1a) (drawing 1 (1a), drawing 1 (1a')).

[0046] (1b) A resist (sacrifice layer) 3 is arranged on the arrangement process of the mask ingredient for "concavo-convex pattern" (2nd layer) formation, next SiO2 film 1 (drawing 1 (1b), drawing 1 (1b')). as for the substrate front face where SiO2 film 1 has been arranged, it is desirable to carry out desiccation etc. in clean oven ultrasonic cleaning and 120 degrees C, and 20 minutes or more every [each / 10] beforehand in an acetone and IPA, and to perform a washing process.

[0047] As the above-mentioned resist (sacrifice layer) 3, although there is especially no limit, the high resolution positive resist corresponding to i line, its high resolution negative resist corresponding to i line, etc. are usable. Here, the AZ5214E positive resist made from Clariant JAPAN was thinned and used with resist thinner liquid.

[0048] Moreover, before applying a resist agent, it is desirable to arrange the finishing agent for adjusting wettability with the resist applied to the front face of said SiO2 film 1. Moreover, in order to obtain the high pore of an aspect ratio according to the anodization process which it is accurate and mentions later the exposure mentioned later, it is also desirable to arrange the reflex-inhibition film for controlling reflection by the interface of a resist and said SiO2 film 1.
[0049] As the above-mentioned finishing agent, HMDS (hexamethyldisilazane) is mentioned, for example. Moreover, what mixed coloring matter in the organic film which decreases the light reflected by the interface as the above-mentioned reflex-inhibition film, for example, or the organic film can be used. As an ingredient of said organic film, Pori Sall John, a polyamide, polyimide, polymethacrylic acid, polymethylmethacrylate, poly methacrylamide, etc. can use preferably. As said coloring matter, a curcumine, a coumarin, etc. can be used, for example. Said reflex-inhibition film is effective in order the reflection factor of a workpiece (in this case, said SiO2 film 1) is high, or to suppress the interference in the resist film and to reduce unevenness of exposure.
[0050] Next, a resist 3 is exposed (drawing 1 (1c), drawing 1 (1c'), drawing 2 (1d), drawing 2 (1d')). Here, two interference exposure shows the example which exposed the resist. However, although it is natural, the exposure approach is not restricted to this approach.
[0051] (1c) 1st interference exposure ... Drawing 1 (1c), drawing 1 (1c')
Interference exposure of the 1st time exposes a resist 3 in the shape of a stripe by exposing in the shape of [two or more] Rhine, as shown in drawing 1 (1c'). The exposure period of the field where 4 was exposed in the shape of a stripe, and 5 show the exposed resist (the 1st time).
[0052] Laser of arbitration, such as an excimer laser, helium-Cd laser, and Ar laser, can be used for the light source used for interference exposure. Here, helium-Cd laser (wavelength of 325nm, TEM00 mode) was used. Although especially the class of laser to be used is not asked since interference exposure can mince a pattern to the half-wave length period of wavelength theoretically, it is desirable to use the laser of short wavelength more to mince detailed structure. Moreover, the laser quality of the stable output and the TEM00 stable mode is desirable.
[0053] (1d) After [the 2nd interference exposure] development ... Drawing 2 , next 2nd interference exposure are performed (drawing 2 (1d), drawing 2 (1d')). The 2nd interference exposure was exposed in the shape of [two or more] Rhine so that the longitudinal direction of the exposure field of the shape of Rhine exposed at a time might be made to intersect (for example, 60 degrees, 90 degrees). Thus, by performing 2nd exposure, the intersection part 8 by the interference fringes of the different direction is formed.
[0054] Next, negatives are developed so that this part 8 exposed strongly may be removed. The mask for forming "the concavo-convex pattern" (the 2nd layer) mentioned later by this development is formed. In addition, in drawing 2 (1d) and drawing 2 (1d'), 6 is spacing of the field 8 exposed strongly, and 7 is an include angle of the direction of the 1st exposure field, and the direction of the 2nd exposure field to make, and is 60 degrees here.
[0055] Since there is an inclination for the pattern of pore to become the repeat of a forward 6 square-shape-like pattern mostly by self-regulation-ization in the pore formation by anodic oxidation, at this time, it is desirable to form "a concavo-convex pattern" (especially crevice) so that it may become the repeat of a forward 6 square-shape-like (shape of honeycomb) pattern mostly. This is desirable especially when it is going to form in stability the nano structure which has deep pore.
[0056] Moreover, in the pore formation by anodic oxidation, spacing of pore is controllable by process terms and conditions, such as the class of electrolytic solution used for anodic oxidation, concentration, temperature and the anodic oxidation electrical-potential-difference impression approach, an electrical-potential-difference value, and time amount, to some extent. Therefore, it is desirable to form "a concavo-convex pattern" (especially crevice) in spacing of the pore expected from process terms and conditions beforehand.
[0057] The resist of a field which is diluting to 1 to 1 and developing negatives about 60 seconds, and exposed the developer with pure water as the development approach here was removed, and opening (1d of drawing 2) penetrated up to SiO2 film 1 front face was formed.
[0058] (1e) a "concavo-convex pattern" (crevice) formation process ... drawing 2 -- here, the crevice 10 which a substrate front face exposes was formed by etching SiO2 film 1, using the resist in which opening obtained by said development carried out was formed as a mask. By this process, it is "concavo-convex pattern" (2nd layer) 1. It is formed (drawing 2 (1e), (1e')). According to this process, as described above, a part of substrate front face is exposed, and connection between the film (workpiece film) which uses as a principal component aluminum arranged behind, and

Si substrate is secured.
[0059] The field (intersection part) 8 (drawing 2 (1d), (1d')) which received the both sides of said the 1st and 2nd exposure is removed by said development process. For the reason, the field corresponding to said intersection part 8 exposes the front face of the Si substrate 2, and opening (crevice) 10 is formed of etching.
[0060] As the above-mentioned etching conditions, it is CF4 here. It carried out by 200W for 3 minutes. In addition, in order to form opening (crevice) 10 (drawing 2 (1e)) in SiO2 film 1, patterning of the resist 3 was carried out here. However, as shown in drawing 9 , drawing 10 , etc., you may use as "a concavo-convex pattern" (the 2nd layer) by arranging directly the resist 39 in which the opening (crevice) 43 to which a substrate front face is exposed was formed, on the above-mentioned substrate front face, without using the SiO2 above-mentioned film 1.
[0061] B: Process (1f) workpiece film formation which arranges a workpiece on a substrate front face ... Drawing 3 (1f) (1f'),
On the above "a concavo-convex pattern" (Si substrate 2 exposed by said opening (crevice) 10 on SiO2 film (heights) 1), the workpiece film (oxide film on anode-ed) 11 is arranged (drawing 3 R> 3 (1f), drawing 3 (1f')).
[0062] Although what uses aluminum as a principal component is mentioned as the quality of the material of a workpiece, if it is the quality of the material in which the pore formation by anodic oxidation is possible, it will not be limited especially. Here, the film which used aluminum as the principal component was used as workpiece film (oxide film on anode-ed) 11.
[0063] Moreover, the membrane formation approach of the workpiece film (film which uses aluminum as a principal component) 11 can apply the membrane formation approach of arbitration including resistance heating vacuum evaporationo, EB vacuum evaporationo, a spatter, CVD, and plating. By doing in this way, as shown in drawing 3 (1f) and drawing 3 (1f'), a crevice 12 is formed in the front face of the film (workpiece film) 11 which uses aluminum as a principal component located in right above [of the opening (crevice) 10 of the above "a concavo-convex pattern"].
[0064] C: Perform process (1g) anodic oxidation which anodizes a workpiece... Drawing 3 (1g) (1g'),
By performing anodizing on the above-mentioned workpiece film 11, the structure (nano structure) of nano size which has pore ((1g) of drawing 3) is produced.
[0065] Of this process, pore 14 is alternatively formed in right above [of the crevice (opening) 10 of the above "a concavo-convex pattern" (the 2nd layer)]. And as already described, as for the ingredient which constitutes the heights (film 1) which constitute "a concavo-convex pattern" (the 2nd layer), it is desirable to have conductivity lower than the ingredient which constitutes said substrate front face (it is the conductive film front face when the conductive film is arranged). And as for the ingredient which constitutes said heights, it is still more desirable that it is an insulating ingredient. Therefore, SiO2 was used here as an ingredient which constitutes said heights (the 2nd layer). The pore formed of the above-mentioned anodic oxidation process by making it this appearance is said film (SiO2) 1. It can be made to go to the field (for the field of the conductive ingredient which constitutes said substrate to be exposed) which is not covered with said film (the 2nd layer), without going. consequently, the pore excellent in linearity -- mutual -- substantial -- parallel -- repeatability -- it can form highly.
[0066] As the electrolytic solution used for anodic oxidation, although oxalic acid, phosphoric acid, a sulfuric acid, a chromic-acid solution, etc. are mentioned, especially if there is no un-arranging in the pore formation by anodic oxidation, it will not be limited, for example. Moreover, terms and conditions according to each electrolytic solution, such as an anodic oxidation electrical potential difference and temperature, can be suitably set up according to the nano structure to produce.
[0067] The path of pore can be suitably extended by pore wide processing formed of the above-mentioned anodic oxidation in which the structure which has pore is dipped into an acid solution (the case of an anodic oxidation alumina for example, phosphoric-acid solution).
[0068] the structure 100 ((1g) of drawing 3) in which pore was finally formed -- ultrapure water -- a stream -- it washes. In drawing 3 (1g) and (1g'), 13 is the alumina to which the film 11 which uses said aluminum as a principal component oxidized by anodic oxidation, and 14 shows the pore formed of anodic oxidation.
[0069] the structure produced by the manufacture approach of this invention -- regularity -- it is high and a desired configuration is equipped with the pore by which array formation was carried out. Moreover, especially in the manufacture approach of this invention, it has the description producible to low cost at a large area in a short time by using the interference exposing method.

[0070]
[Example] An example is given to below and this invention is concretely explained to it.
[0071] - (2a') (2e') of a typical sectional view [in / in - (2a) (2e) of example 1 drawing 4 and drawing 5 / each process of this example], drawing 4 , and drawing 5 shows the top view. In this example, "a concavo-convex pattern" is formed by deleting a part of front face of a substrate 16, aluminum film vapor-deposited on it is anodized, and pore is formed.
[0072] Drawing 4 and drawing 5 are used for below, and this example is explained to it.
(1) After an acetone, washing by IPA, and desiccation, with a spin coat method, apply the resist film (200nm of thickness) 15 of a positive type, and dry the n-Si substrate 16 (90 degrees C, 20 minutes).
[0073] (2) Next, produce the concavo-convex pattern by the resist with the periodic stripe-like structure (spacing of 230nm) 17 using interference exposure. helium-Cd laser (lambda= 325nm, 230nm spacing of interference fringes) is used, and, specifically, it is exposure 29.5 mJ/cm2. It exposes. the shape of a stripe penetrated to the n-Si substrate front face in diluting a developer with pure water to 1 to 1, and developing it about 30 seconds with it is regular -- "a concavo-convex pattern" is formed. (Refer to (2a) of drawing 4 , and (2b))
[0074] (3) Next, etch exposed Si substrate by using as a mask the resist 15 created at said process, and remove the resist which remained ((2c) of drawing 4 , (2c')). As etching conditions, it is CF4. For [200] W or 3 minutes were performed under 1.2Pa. In drawing 4 , the heights by which 18 was formed in the n-Si substrate front face, and 19 show the crevice formed in the n-Si substrate front face. (Reference of drawing 4 (2c))
[0075] (4) Next, form the aluminum film (500nm of thickness) 20 and 21 on an n-Si substrate front face. The irregularity reflecting the irregularity formed in the n mold Si substrate front face was formed in the front face of a workpiece which consists of aluminum ((2d) of drawing 5 , (2d')). In drawing 5 , 20 is the heights formed in the front face of aluminum film, and 21 shows the crevice formed in aluminum film front face. (Reference of drawing 5 (2d))
[0076] (5) Next, aluminum film oxidized to the alumina 22 by anodizing by 100V in phosphoric-acid 0.3M solution. Consequently, the structure which has the pore 23 extended toward the crevice formed in the substrate front face with the crevice 21 of said aluminum film front face as the starting point was obtained ((2e) of drawing 5 , reference (2e')).
(6) Finally the structure which has pore was immersed in the 5wt% phosphoric acid for 30 minutes, and processing to which the path of pore is expanded was performed.
<Evaluation> The structure of the nano size produced by the above-mentioned approach was observed by FESEM. Corresponding to the crevice of the resist formed at intervals of 230nm, it has checked that array formation of the pore 23 of the shape of cell size about 266nm and a cylinder like hole diameter 100nm was carried out.
[0077] - (3a) (3g) of example 2 drawing 6 - drawing 8 is a typical sectional view in each process of this example, and - (3a') (3g') of drawing 6 - drawing 8 shows the top view.
[0078] Drawing 6 and drawing 7 are used for below, and this example is explained to it.
(1) First, after an acetone, washing by IPA, and desiccation, with the spin coat method, the reflex-inhibition film 24 (100nm of thickness) and the resist film 26 (200nm of thickness) of a positive type were applied, and the n-Si substrate 25 was dried (90 degrees C, 20 minutes). ((3a) of drawing 6 , reference (3b)) . In addition, in this example, AZBARi-100 made from Clariant JAPAN were used as an ingredient of an antireflection film.
(2) Next, the "concavo-convex pattern" which consists of a resist arranged in the shape of a honeycomb like the laser interference exposure mentioned above was produced.
[0079] In this example, helium-Cd laser (lambda= 325nm, 230nm spacing of interference fringes) is used, and it is dose 29.5 mJ/cm2. 1st exposure was performed and the resist 26 was exposed in the shape of [28] a stripe ((3c) of drawing 6 , (3c')).
[0080] Next, the 2nd direction of an interference fringe is shifted 60 degrees from an interference fringe in the 1st interference exposure process, and it is dose 29.5 mJ/cm2. It exposed and the resist 26 was exposed in the shape of [32] a stripe ((3d) of drawing 7 , (3d')).
[0081] Then, field 31 which received the 1st time and the 2nd above-mentioned exposure in diluting a developer with pure water to 1 to 1, and developing it about 60 seconds with it (intersection part) It removes alternatively. according to this process, it has the crevice (opening) penetrated to the front face of the reflex-inhibition film 24 in a part of resist -- regular -- "a concavo-convex pattern" is formed. The periodic stripe-like spacing (exposure period) 27 is 230nm, and 29 are x(2/root3) 230**266nm in periodic spacing (spacing) of the exposure intersection part 31. ((3c) of drawing 6 ,

reference of drawing 7 (3d))
[0082] (3) Next, etch with the resist 26 remained and form "concavo-convex pattern" 24 ((3e) of drawing 7 , (3e')). As etching conditions, for [200] W or 4 minutes are performed for Ar under 1.2Pa. It is removed substantially, and the reflex-inhibition film 24 of the field corresponding to opening of a resist is etched by this process, and the front face of a substrate 25 exposes the resist which remained according to it (reference of drawing 7 (3e)).
[0083] (4) Next, form the aluminum film (500nm of thickness) 34. Irregularity is made on the front face of the workpiece 34 of aluminum film reflecting the structure of "the concavo-convex pattern" formed of the above-mentioned process. (Reference of drawing 8 (3f))
[0084] (5) And anodize by phosphoric-acid 0.3M solution and 130V. It was formed toward the substrate 25 which pore exposed according to this process with the crevice 36 of aluminum film front face as the starting point as shown in (3g) of drawing 8 .
[0085] (6) Finally, it was immersed in the 5wt% phosphoric acid for 30 minutes, puncturing processing which extends the path of pore was performed, and the pore 38 which carried out minute restoration regularly was obtained.
[0086] <Evaluation> The nano structure produced by the above-mentioned approach was observed by FESEM. It has checked that the perfect circle pore 38 whose spacing 29 which carried out the roppo array regularly is about 266nm and like hole diameter 100nm was formed.
[0087] - (4a) (4d) of example 3 drawing 9 and drawing 10 shows the typical sectional view in each process of this example, and - (4a') (4d') of drawing 9 and drawing 10 shows the mimetic diagram. the four-way-type array was carried out in this example -- regular -- "the concavo-convex pattern" is formed. Here, a four-way-type array is arranged in the location of each square top-most vertices, as described in (4c') of crevice drawing 10 of "a concavo-convex pattern."
[0088] The process of this example is explained below.
(1) First, after an acetone, washing by IPA, and desiccation, with a spin coat method, apply the resist film 39 (200nm of thickness) of a negative mold to the front face of a substrate 40, dry on it (90 degrees C, 20 minutes), and form the n-Si substrate 40 in it. (Reference of drawing 9 (4a))
[0089] (2) Next, produce "the concavo-convex pattern" with which a crevice consists of a resist which carried out the four-way-type lattice regularly using the above-mentioned interference exposing method. In this example, helium-Cd laser (lambda= 325nm, 230nm spacing of interference fringes) is used, and it is exposure 29.5 mJ/cm2. 1st exposure is performed. The direction of an interference fringe is shifted 90 degrees from an interference fringe in a 1st interference exposure process like (4b') of drawing 9 , and it is exposure 29.5 mJ/cm2. It exposes. then, since an exposure intersection becomes convex, the part 43 which was not exposed is removed and it becomes a concave in diluting a developer with pure water to 1 to 1, and developing it about 30 seconds with it, it has the crevice which the base front face exposed -- regular -- "a concavo-convex pattern" ((4b') of drawing 9) is formed. The periodic stripe-like spacing (exposure period) 41 is 230nm, and periodic spacing of an exposure intersection part is 230nm.
[0090] (3) Form the aluminum film (500nm of thickness) 44. A crevice 47 and heights 46 are made also on the front face of a workpiece (aluminum film) reflecting the structure of the above "a concavo-convex pattern." (Reference of drawing 10 (4c))
[0091] (4) Anodize by phosphoric-acid 0.3M solution and 130V. It was formed toward the front face of the substrate 25 which pore exposed according to this process with the crevice 36 of aluminum film front face as the starting point as shown in (4d) of drawing 10 . (5) Finally, it was immersed in the 5wt% phosphoric acid for 30 minutes, and puncturing processing which extends the path of pore was performed.
[0092] <Evaluation> The nano structure produced by the above-mentioned approach was observed by FESEM. It has checked that the pore 49 of the shape of the spacing of about 230nm which carried out the four-way-type array regularly, and a cylinder like hole diameter 100nm was formed.
[0093] - (6a) (6g) of example 4 drawing 11 - drawing 12 is process drawing showing the manufacture approach of magnetic-substance Co embedding to the nano structure with regular pore.
[0094] (1) SiO2 film 63 was first formed on the front face of the Si substrate 64. Then, the "concavo-convex pattern" by the resist which had periodic structure by interference exposure on said SiO2 film was produced like the above-mentioned example 2, and etching processing was performed. ((6b) of drawing 11 , reference (6c))
[0095] (2) Next, form the aluminum film 67 (500nm). (Reference of drawing 11 (6d))
(3) Next, anodize by phosphoric-acid 0.3M electrical-potential-difference 130V. Anodic oxidation was completed with

reduction of the current value in a current profile. It was formed toward the front face of the substrate 64 which pore exposed with the crevice of aluminum film front face as the starting point according to this process as shown in (6d) of drawing 11 , and (6e) of drawing 12 .
[0096] (4) Next, it is immersed in a 5wt% phosphoric acid for 30 minutes, and perform puncturing processing which extends the path of pore. (Reference of drawing 12 (6e))
(5) Next, soak in Co electrodeposition liquid and electrodeposit Co69. (Reference of drawing 12 (6f)) Co is filled up with said pore 62 according to this process.
(6) Finally, use a diamond slurry with a particle size of 500A, and grind and carry out flattening of the front face. (Reference of drawing 12 (6g))
[0097] <Evaluation> The nano structure produced by the above-mentioned approach was observed by FESEM. It has checked that the pore of the shape of the spacing of about 266nm shape[of a honeycomb]-arranged regularly and a cylinder like hole diameter 100nm was uniformly filled up with Co.
[0098] - (7a) (7d) of example 5 drawing 13 is process drawing showing the pore formation approach of using a stamper.
[0099] (1) Carry out the coat of Cu70 on n-Si71. (Reference of drawing 13 (7a))
(2) The hollow was formed on Cu by giving the pressure of 4.0x108Pa (4 t pile/cm2) for the stamper 72 in which the dot was formed, on said Cu using a hydraulic press machine on a silicon substrate. (Reference of drawing 13 (7b))
[0100] (3) Form the aluminum film (500nm of thickness) 73. Irregularity is made according to the structure of a bottom mask on a workpiece. (Reference of drawing 13 (7c))
(4) Anodize by phosphoric-acid 0.3M solution and 130V. (Reference of drawing 13 (7d))
(5) If it is immersed in a 5wt% phosphoric acid for 30 minutes and puncturing processing is finally performed, the pore shape[of a honeycomb]-arranged regularly will be obtained.
[0101] <Evaluation> The nano structure produced by the above-mentioned approach was observed by FESEM. It has checked that the pore of the shape of a cylinder shape[of a honeycomb]-arranged regularly was formed.
[0102] - (8a) (8d) of example 6 drawing 14 is the pore formation approach of using FIB (focused ion beam).
[0103] (1) Form the Nb film 75 on the n-Si substrate 76. (Reference of drawing 14 (8a))
(2) The focused ion beam exposure 77 was performed on the Nb film 75 using focusing ion beam machining equipment. The ion kind of focusing ion beam machining equipment is Ga, and acceleration voltage is 30kV. The "concavo-convex pattern" which has a crevice so that it may become a honeycomb-like array was formed. However, in this example, although the field of a request of the film of Nb was etched by FIB processing and the crevice was formed, substrate 76 front face was made to be not exposed (reference of drawing 14 (8b)).
[0104] (3) Form the aluminum film (500nm of thickness) 78. Irregularity is made also on aluminum film front face reflecting the crevice and heights of the above "a concavo-convex pattern." (Reference of drawing 14 (8c))
(4) Anodize by phosphoric-acid 0.3M solution and 130V. Of this process, as shown in (8c) of drawing 14 , and (8d) of drawing 14 , pore was formed toward the crevice of Nb film with the crevice of aluminum film front face as the starting point.
[0105] Finally, it is immersed in a 5wt% phosphoric acid for 30 minutes, puncturing processing which extends the path of pore is performed, and the pore 62 shape[of a honeycomb]-arranged regularly is obtained.
[0106] <Evaluation> The nano structure produced by the above-mentioned approach was observed by FESEM. It has checked that the pore of the shape of the spacing of about 100nm shape[of a honeycomb]-arranged regularly and a cylinder like hole diameter 50nm was formed. Moreover, it was formed by this example, and the termination had stopped at the crevice front face of the Nb film 75, and pore 62 had the high homogeneity of the depth of pore.
[0107] In addition, although "the concavo-convex pattern" was formed in this example by arranging the electric conduction film 75 on a substrate 76, and removing a part of this electric conduction film 75, a part of front face of a substrate 76 may be removed, and "a concavo-convex pattern" may be formed by arranging the electric conduction film on this front face. In this case, the thing which do not fill with the electric conduction film the crevice formed in said substrate 76 front face and to arrange like is required.
[0108] - (9a) (9g) of example 7 drawing 15 - drawing 17 shows the cross section of each process in this example, and - (9a') (9g') of drawing 15 - drawing 17 shows the mimetic diagram.
[0109] To the following The creation process of this example is shown. First, it arranges in order of titanium 82, copper

81, and SiO2 film 84 on the front face of a glass substrate 83. (Reference of drawing 15 (9a))
And the resist material of a positive type is applied and dried with a spin coat method (90 degrees C, 20 minutes), and the resist film 85 (200nm of thickness) is formed. (Reference of drawing 15 (9b))
[0110] Next, the "concavo-convex pattern" which has the shape[of a honeycomb]-arranged crevice like said example 2 using interference exposure and which consists of a resist was produced. Using helium-Cd laser (lambda= 325nm, 230nm spacing of interference fringes), 1st exposure is performed by dose 29.5 mJ/cm2, and a resist exposes in the shape of a stripe ((9c') of drawing 15). The 2nd direction of an interference fringe is shifted 60 degrees from an interference fringe in the 1st interference exposure process, and it is exposure 29.5 mJ/cm2. It exposes ((9d') of drawing 16).
[0111] then, a developer is diluted with pure water to 1 to 1, the exposure intersection 89 is removed in developing negatives about 60 seconds, and it has opening (concave) penetrated to the front face of SiO2 film 84 -- regular -- "a concavo-convex pattern" is formed. The periodic stripe-like spacing 86 is 230nm, and 88 is x(2/root3) 230**266nm in periodic spacing of an exposure intersection part. ((9c) of drawing 15 R> 5, reference of drawing 16 (9d))
[0112] Next, SiO2 film 84 is etched by using the above "a concavo-convex pattern" as a mask ((9e') of drawing 16 (9e) and drawing 16). Etching removal of the SiO2 film exposed by opening (crevice) of said resist is carried out by this process, and "the concavo-convex pattern" which consists of SiO2 is formed. As etching conditions, it is CF4. For [200] W or 3 minutes are performed under 1.2Pa. Then, the acetone washed and the resist which remains was removed completely.
[0113] Next, the aluminum film (500nm of thickness) 92 is formed. Irregularity is made on the front face of aluminum film which is a workpiece reflecting the crevice and heights of "the concavo-convex pattern" which consists of the above SiO2. ((9f) of drawing 17 , (9f'))
And it anodized by phosphoric-acid 0.3M solution and 100V. It was formed toward the Cu film 81 (opening formed in SiO2 film 84 (crevice)) which pore exposed according to this process with the crevice of the front face of the aluminum film 92 as the starting point as shown in (9g) and (9g') of drawing 17 .
[0114] Finally, it was immersed in the 5wt% phosphoric acid for 30 minutes, puncturing processing which extends the path of pore was performed, and the regular pore 96 was obtained.
[0115] <Evaluation> The nano structure produced by the above-mentioned approach was observed by FESEM. Corresponding to the crevice of the interference fringe of 230nm spacing, array formation of the pore 96 of the shape of cell size about 266nm and a cylinder like hole diameter 100nm was carried out at high density.
[0116]
[Effect of the Invention] As explained above, there is the following effectiveness in this invention.
(1) The manufacture approach of the microstructure of this invention can produce the high nano structure of an aspect ratio covering a large area in cheapness, ease, and a short time.
(2) The manufacture approach of the microstructure of this invention is controlling the concavo-convex pattern formed on a base, and random-arrangement-izing of pore is still more possible for it to random-arrangement-izing of the formation start point of pore, and a pan.
(3) Moreover, since the formation start point of the crevice on a base and the pore on a workpiece is formed on a straight line, the manufacture approach of the microstructure of this invention can produce a linear alumina nano hole.
[0117] (4) Moreover, the manufacture approach of the microstructure of this invention is possible by all approaches, such as interference exposure and a focused ion beam, to the concavo-convex pattern formation on a base.
(5) Moreover, by using together an interference exposure process and the self-organization-process of anodic oxidation, the manufacture approach of the microstructure of this invention can conquer that a high aspect ratio pattern cannot be minced, in order that the conventional interference exposure may use the interference wave of a sinusoidal component.
(6) Moreover, when interference exposure is used, in two points of point ** which does not have to carry out direct irregularity pattern formation to a workpiece front face far by the large area, the point which can produce the regular nano structure by low cost, electron beam lithography, etc., and does not damage a workpiece, it is more practical than using semi-conductor processing techniques, such as X-ray lithography and electron beam lithography.
[0118] (7) Moreover, this invention makes it possible to apply the pore object of an anodic oxidation alumina with various gestalten, and extends the application range remarkably. The nano structure of this invention can also be used as the base material of the further new nano structure, mold, etc., although it is usable as a functional material in itself.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is process drawing showing an example of the manufacture approach of this invention.
[Drawing 2] It is process drawing showing an example of the manufacture approach of this invention.
[Drawing 3] It is process drawing showing an example of the manufacture approach of this invention.
[Drawing 4] It is process drawing showing an example of the manufacture approach in the example of this invention.
[Drawing 5] It is process drawing showing an example of the manufacture approach in the example of this invention.
[Drawing 6] It is process drawing showing an example of the manufacture approach in another example of this invention.
[Drawing 7] It is process drawing showing an example of the manufacture approach in another example of this invention.
[Drawing 8] It is process drawing showing an example of the manufacture approach in another example of this invention.
[Drawing 9] It is process drawing showing an example of the manufacture approach in another example of this invention.
[Drawing 10] It is process drawing showing an example of the manufacture approach in another example of this invention.
[Drawing 11] It is process drawing showing an example of the manufacture approach in another example of this invention.
[Drawing 12] It is process drawing showing an example of the manufacture approach in another example of this invention.
[Drawing 13] It is process drawing showing an example of the manufacture approach in another example of this invention.
[Drawing 14] It is process drawing showing an example of the manufacture approach in another example of this invention.
[Drawing 15] It is process drawing showing an example of the manufacture approach in another example of this invention.
[Drawing 16] It is process drawing showing an example of the manufacture approach in another example of this invention.
[Drawing 17] It is process drawing showing an example of the manufacture approach in another example of this invention.
[Description of Notations]
1 SiO2
2 Si Substrate
3 Resist
4 Exposure Period
5 Exposed Resist (the 1st Time)
7 60 Degrees
8 Intersection Part Exposed Strongly

9 Exposed Resist (it Has Shifted the 2nd Time : 60 Degrees)
10 Crevice
11 Film Which Uses Aluminum as Principal Component
12 Crevice of Aluminum
13 Alumina
14 Pore
15 Positive Resist
16 n-Si
17 Exposure Period
18 N-Si Heights
19 N-Si Crevice
20 Aluminum Heights
21 Aluminum Crevice
22 Alumina
23 Pore
24 Reflex-Inhibition Film
25 n-Si
26 Positive Resist
27 Exposure Period
28 Resist Exposure Section
29 Spacing
31 Intersection Part Exposed Strongly
32 2nd Exposure Section
33 Pore Section
34 Aluminum Film
35 Aluminum Heights
36 Aluminum Crevice
37 Alumina
38 Pore
39 Negative Resist
40 n-Si
41 Exposure Period
42 90 Degrees
43 Crevice
44 Aluminum Film
45 Spacing
46 Heights
47 Crevice
48 Alumina
49 Pore
63 SiO2
64 Si
65 Resist
66 Exposure Period
67 Aluminum Film
68 Alumina
69 Co
70 Cu
71 n-Si
72 Stamper

73 Aluminum Film
74 Alumina
75 Nb
76 n-Si
77 Focused Ion Beam
78 Aluminum Film
79 Alumina
81 Copper
82 Titanium
83 Glass Substrate
84 SiO2 Film
85 POJIREJISUTO Film
86 Exposure Period
87 Resist Exposure Section
88 Spacing
89 Intersection Part Exposed Strongly
91 Pore Section
92 Aluminum Film
93 Aluminum Crevice
94 Alumina
96 Pore

[Translation done.]

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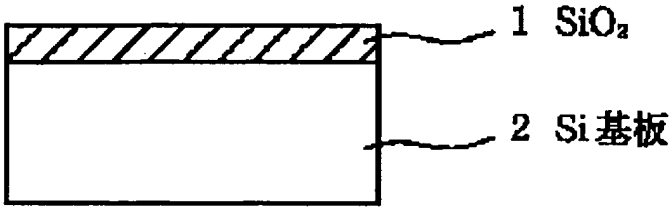

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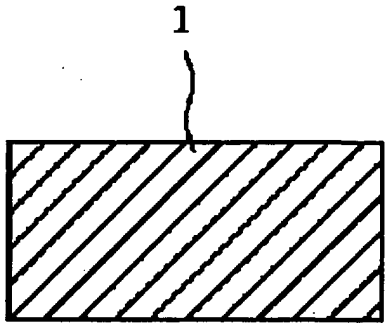

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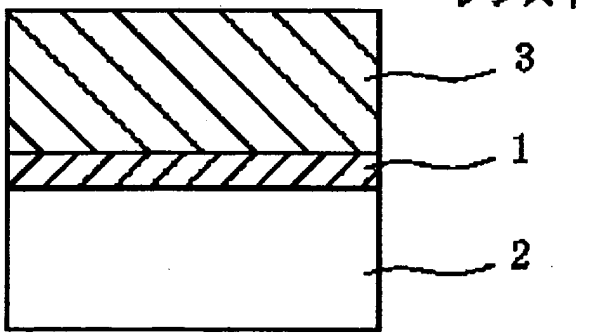

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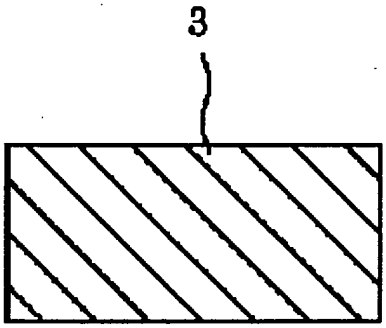

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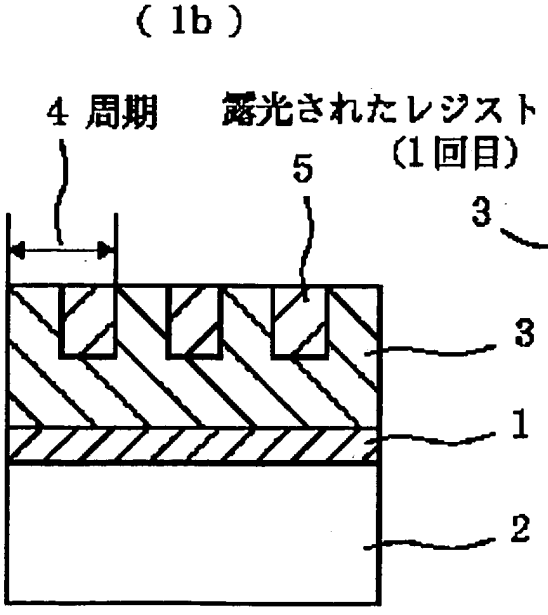

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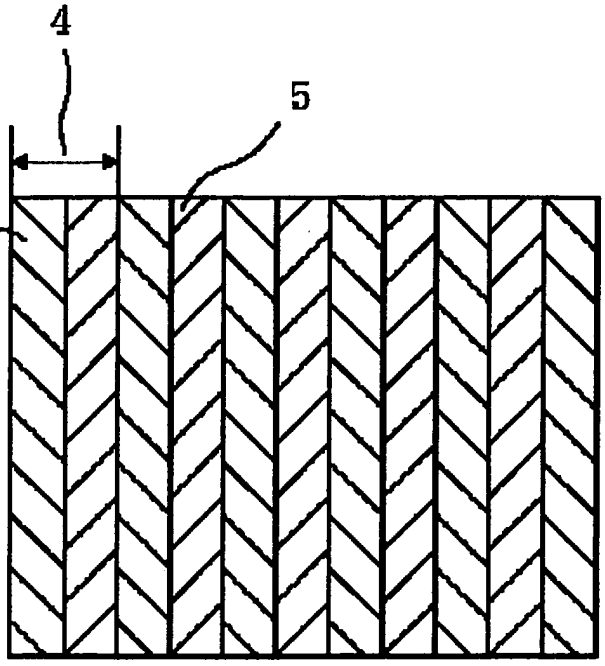

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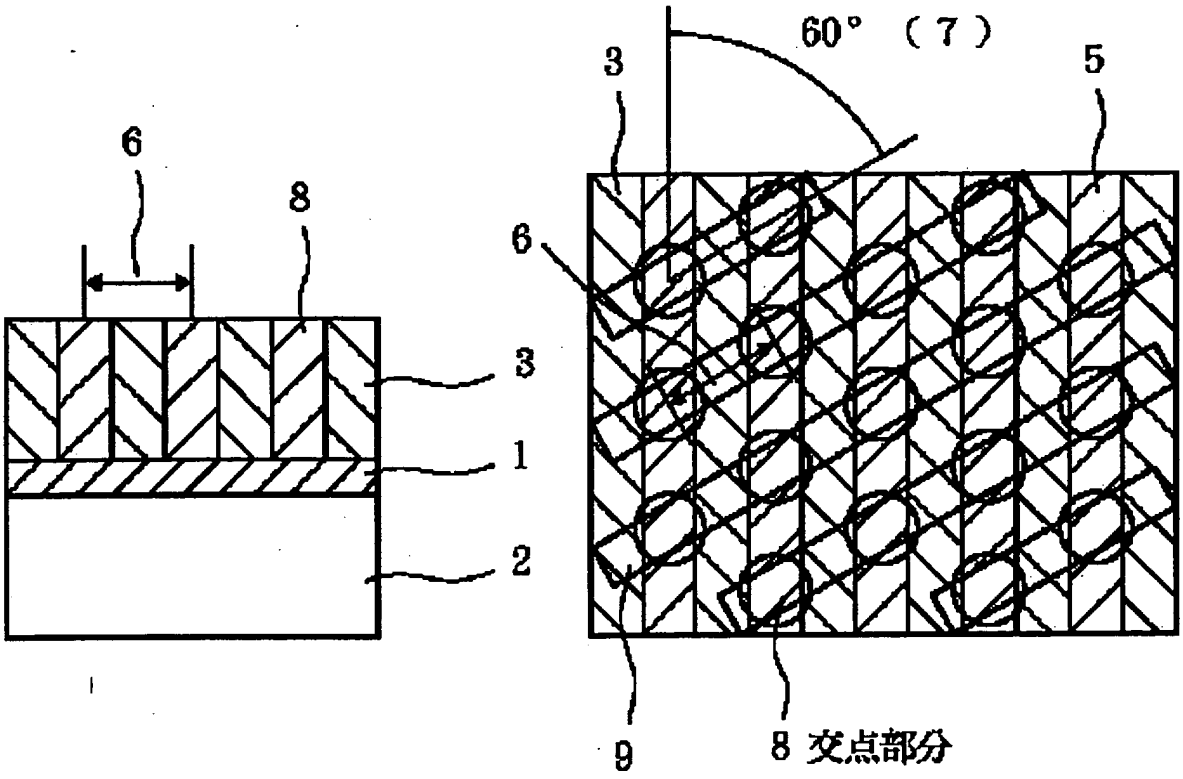

感光されたレジスト（2回目）

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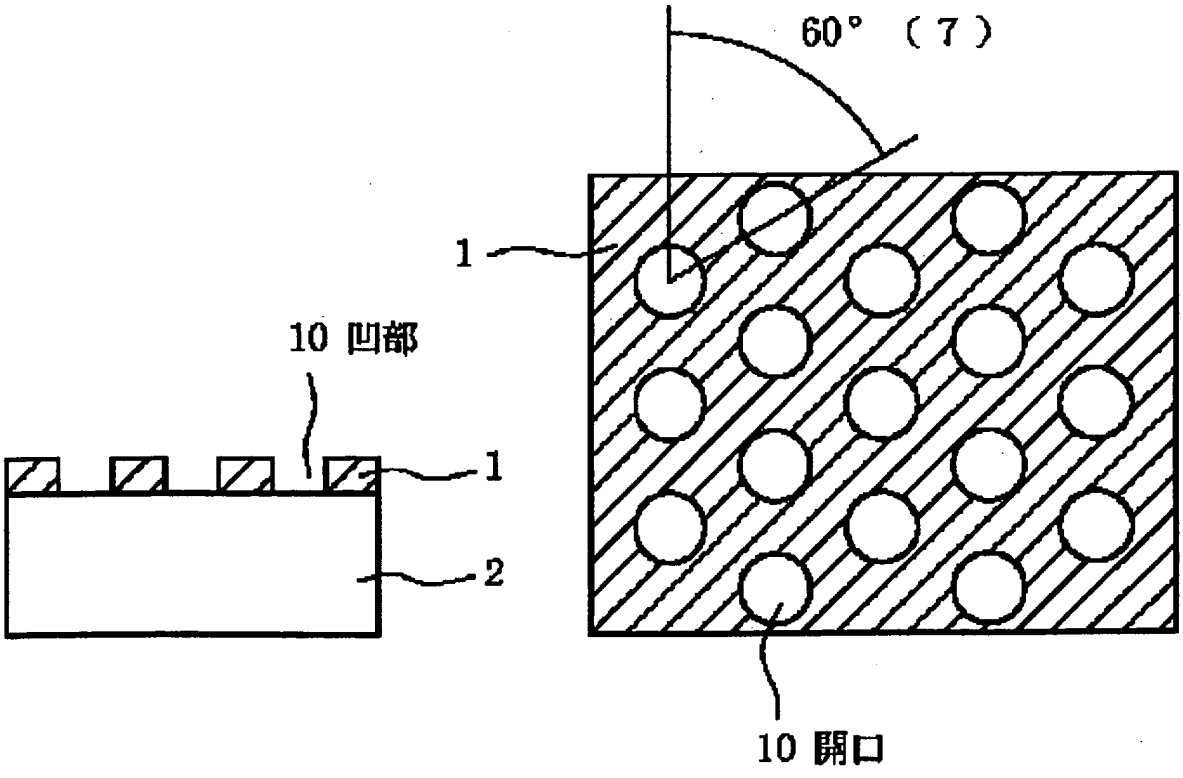

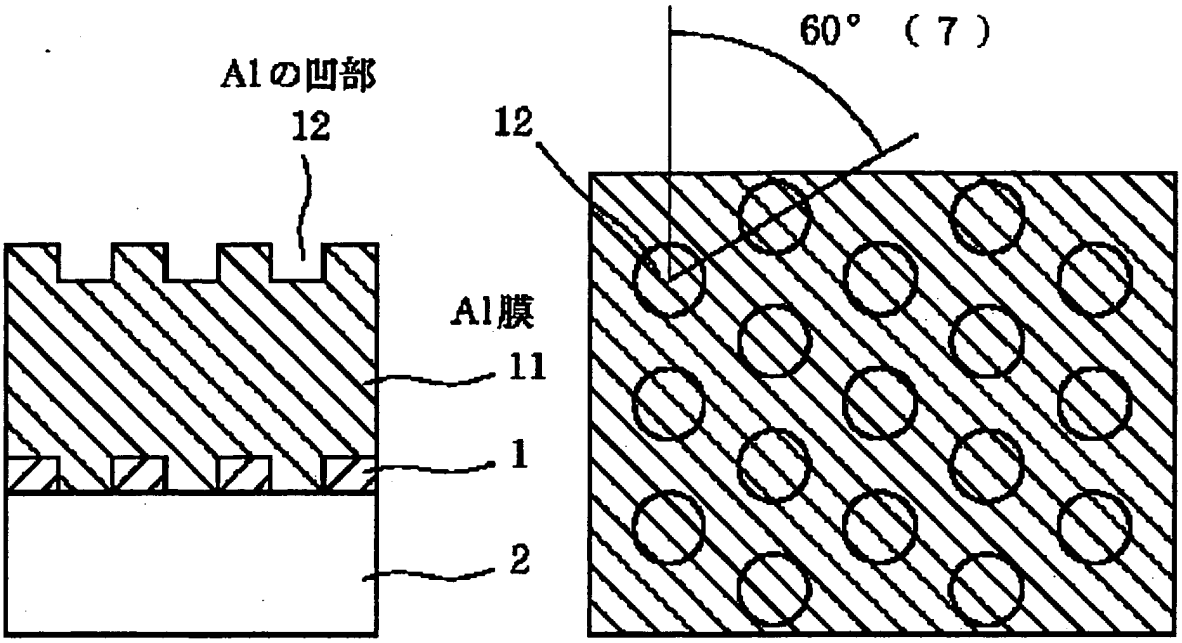

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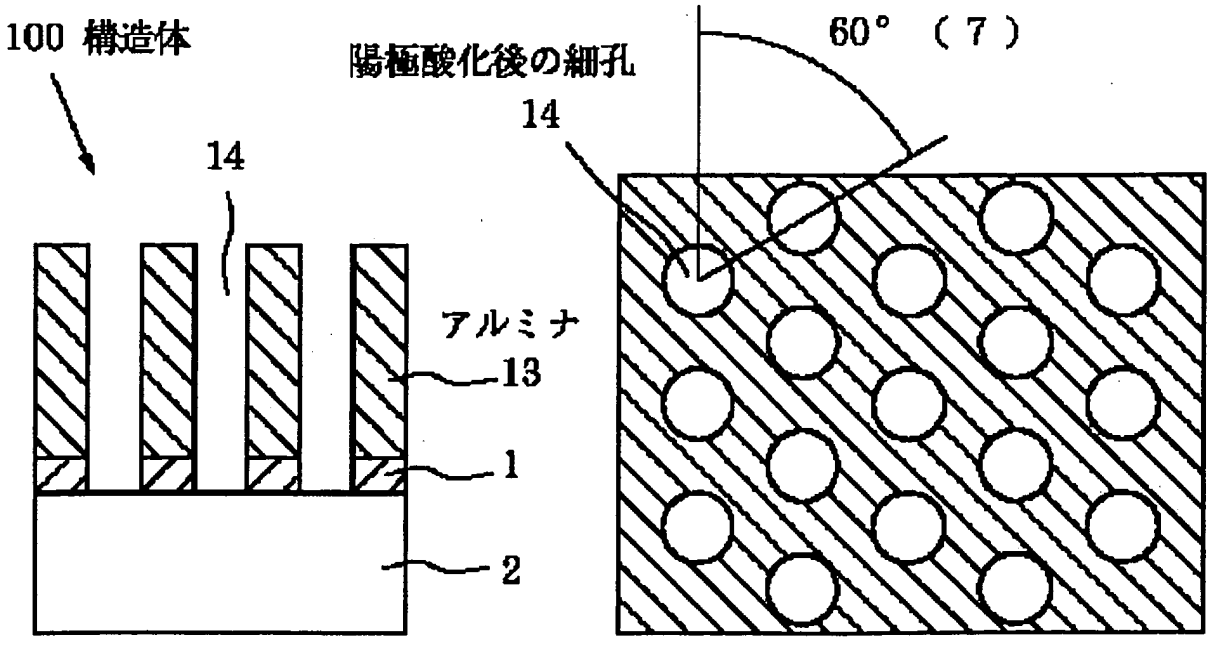

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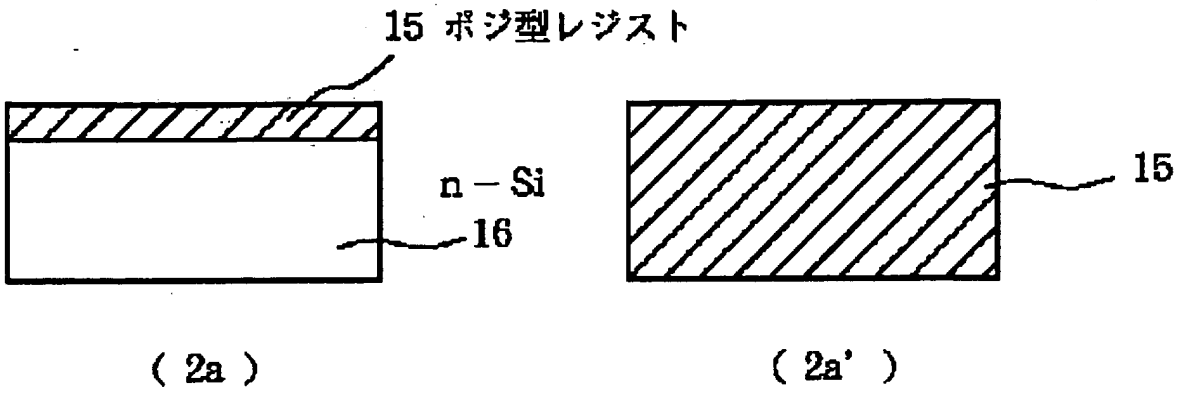
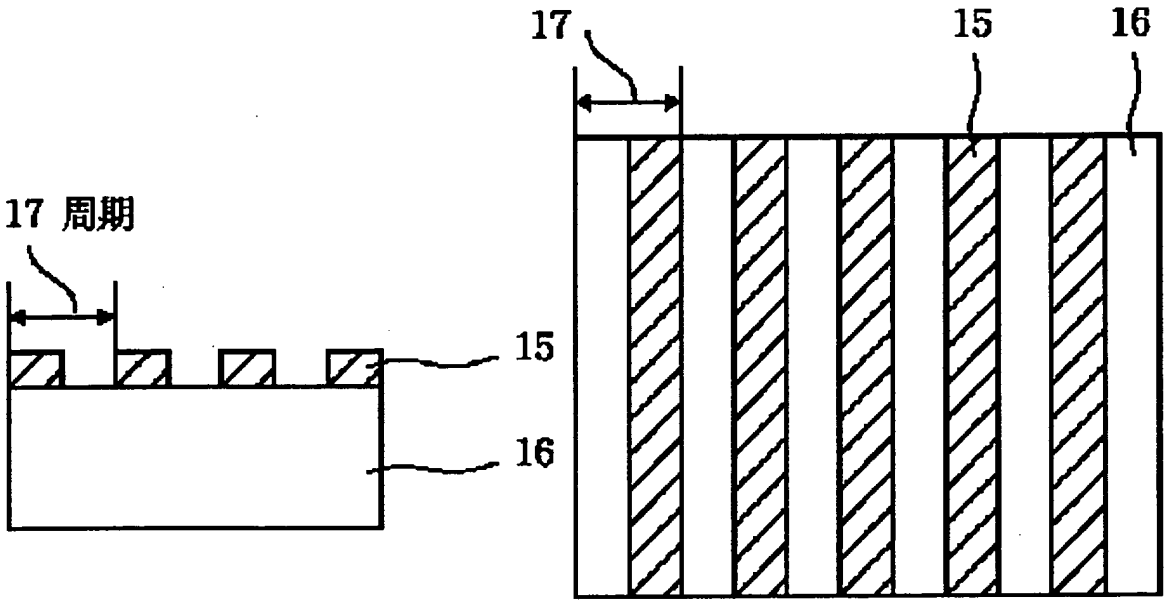

15 ポジ型レジスト
n－Si
16
15

(2a)　　(2a')


17 周期
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16
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15
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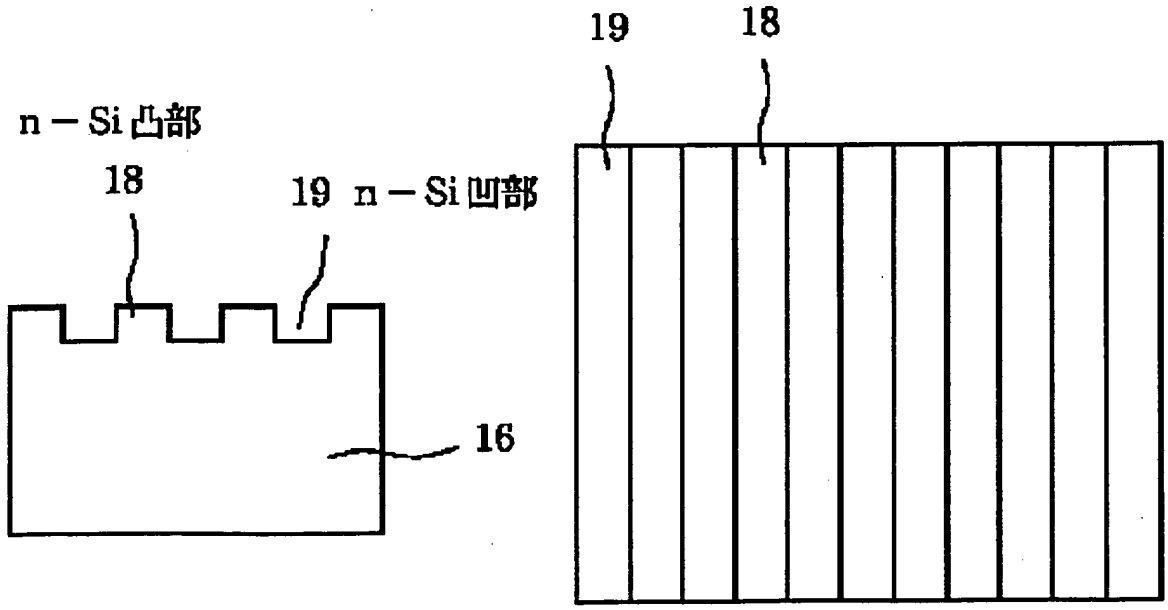
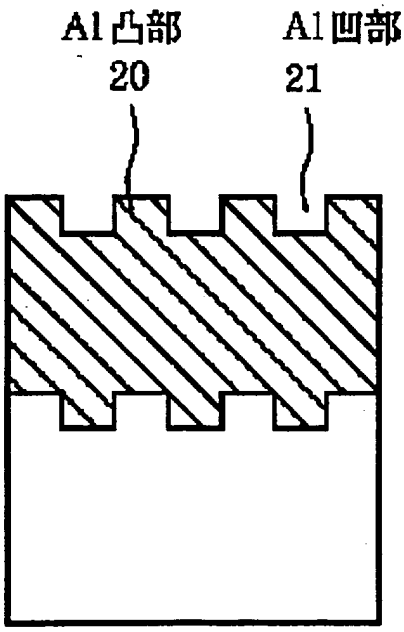

n－Si凸部
18
19 n－Si凹部
16
19
18



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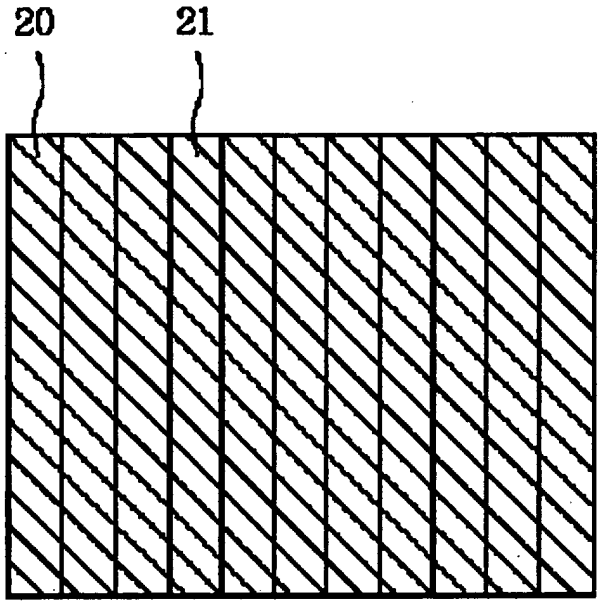

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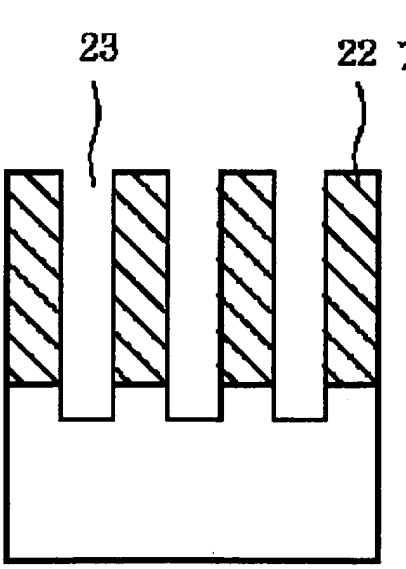

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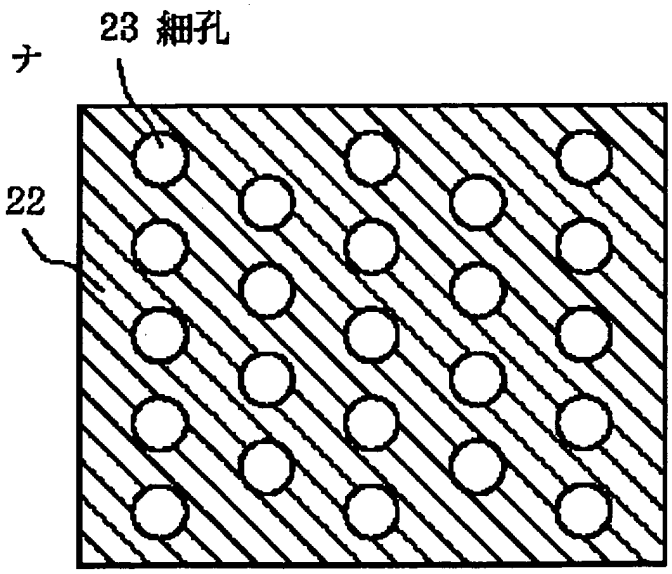

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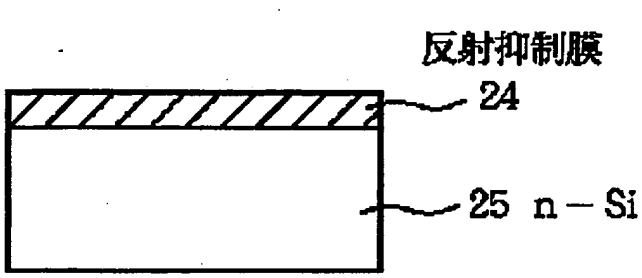

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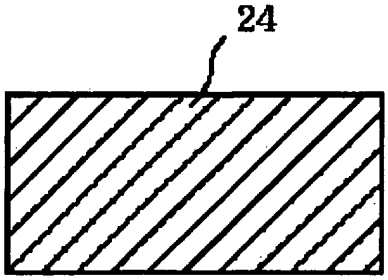

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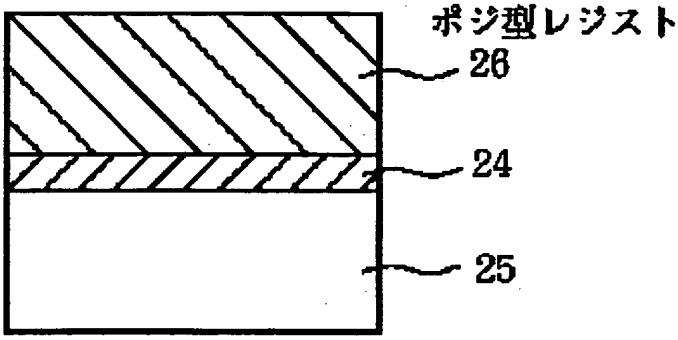

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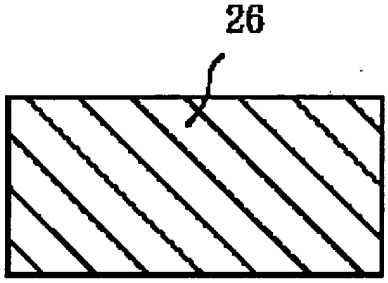

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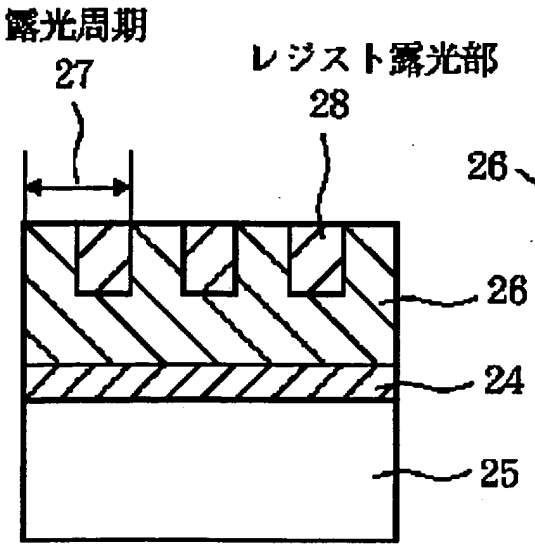

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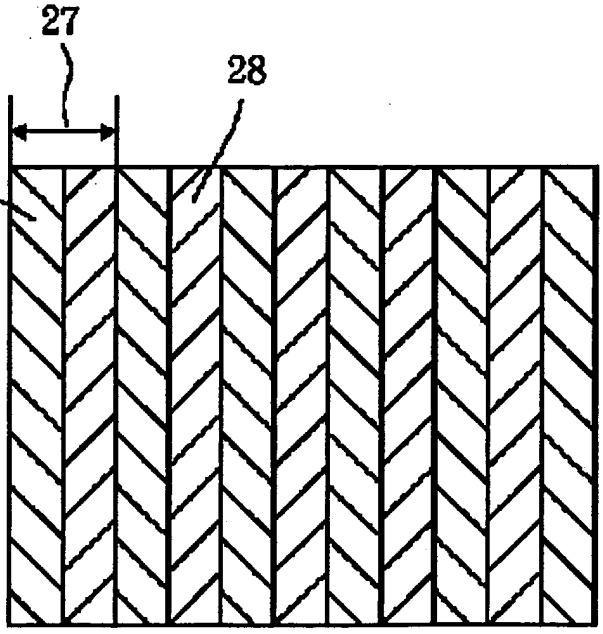

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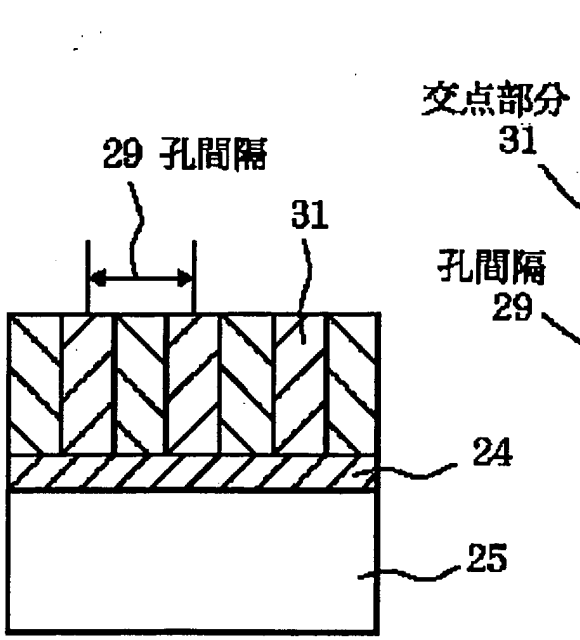

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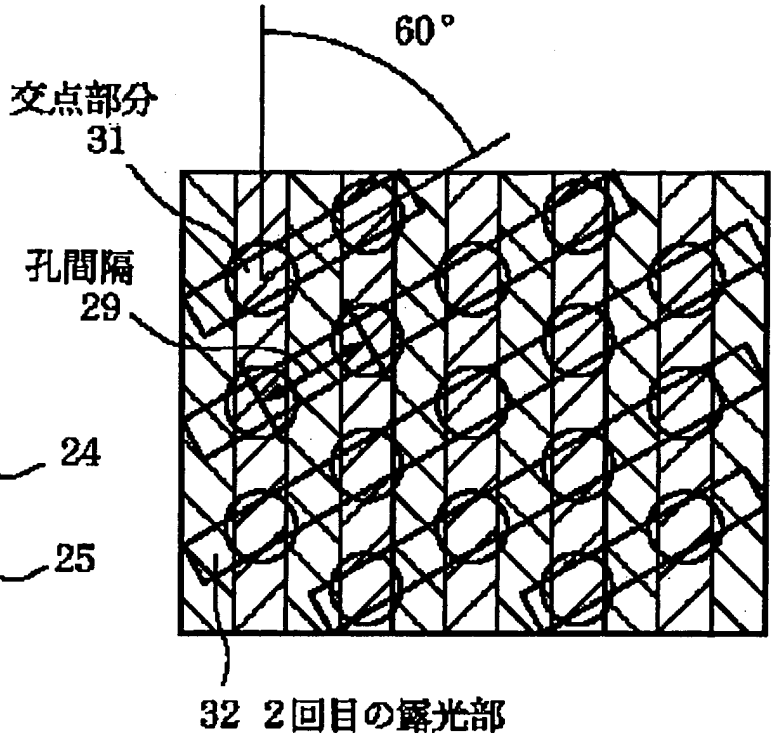

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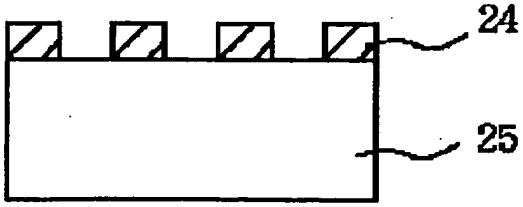

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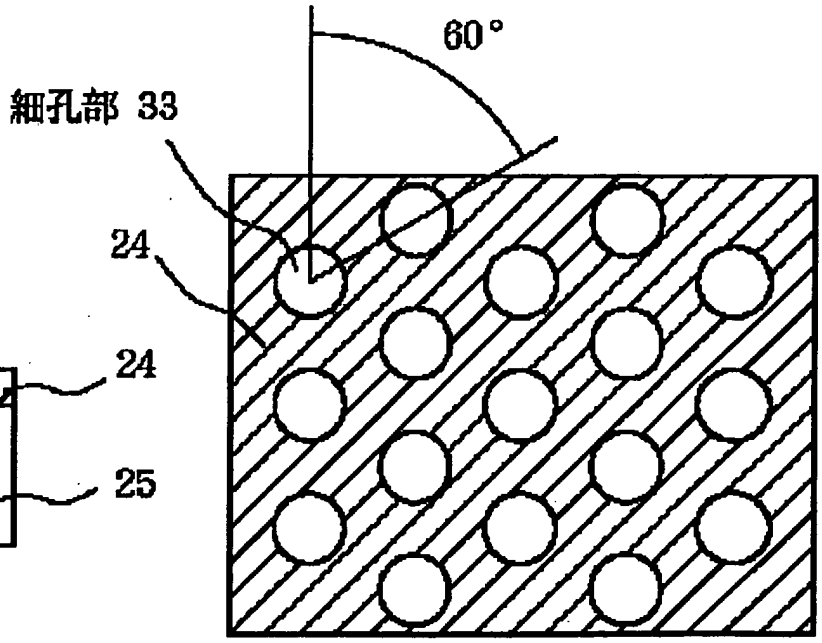

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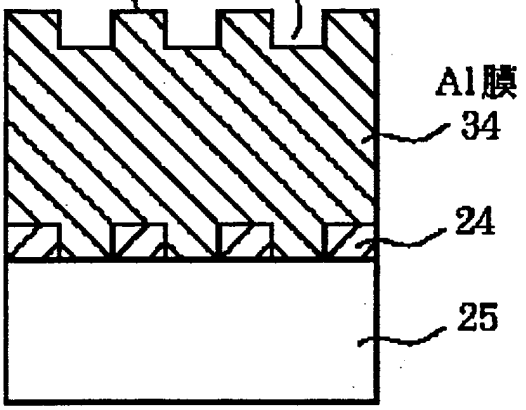

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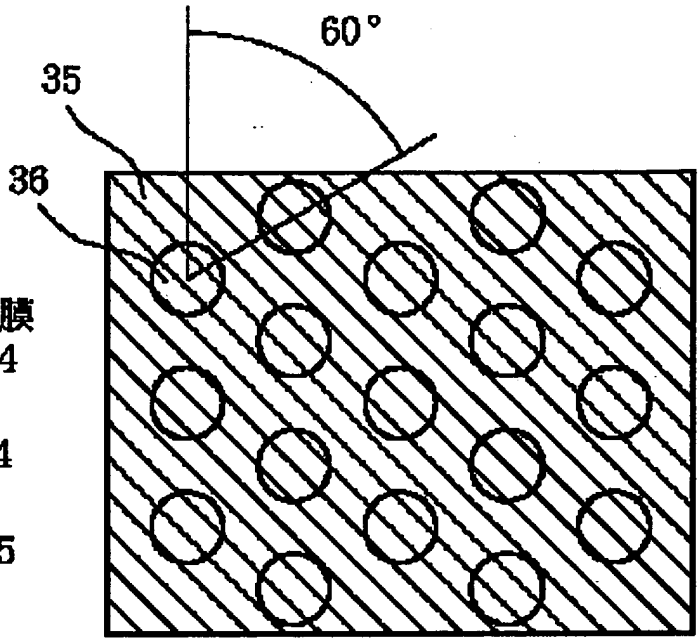

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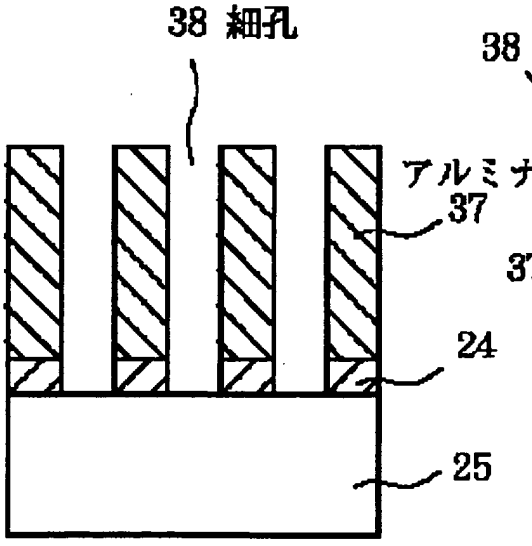

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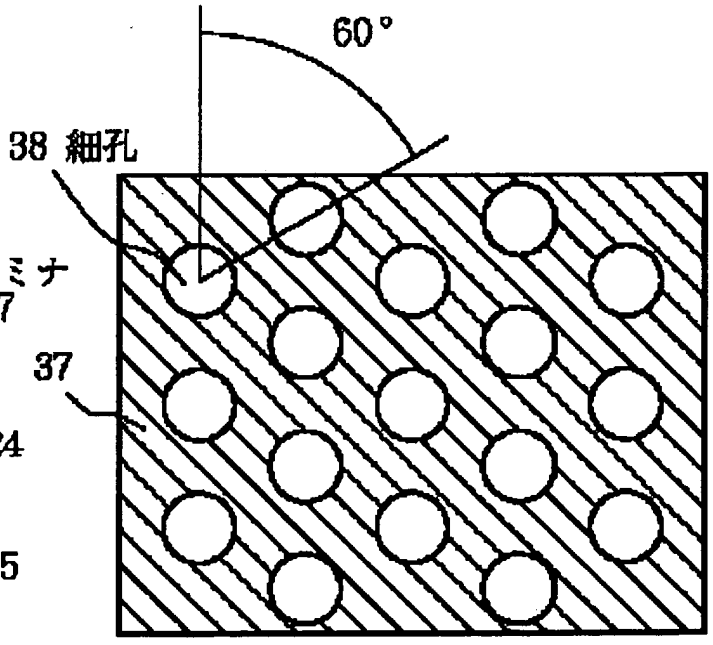

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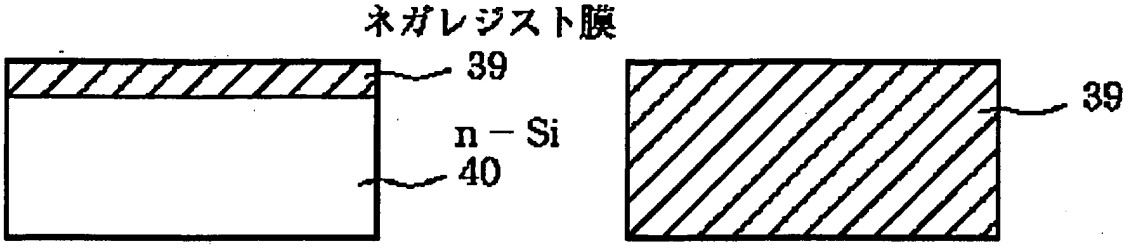

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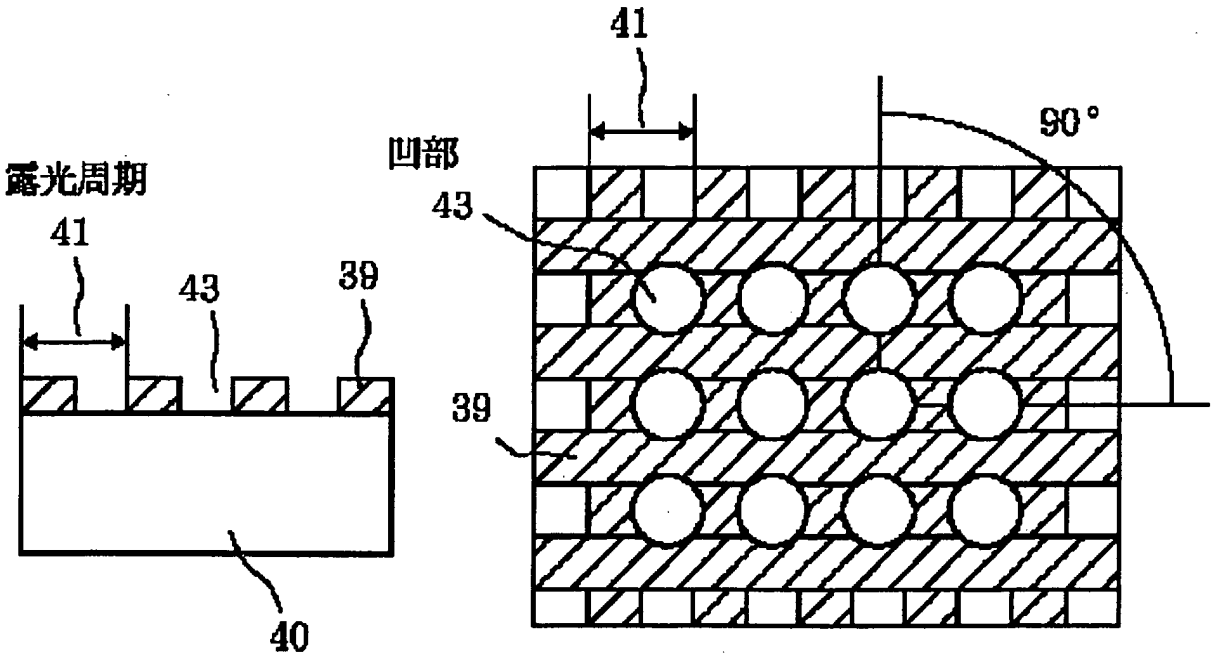

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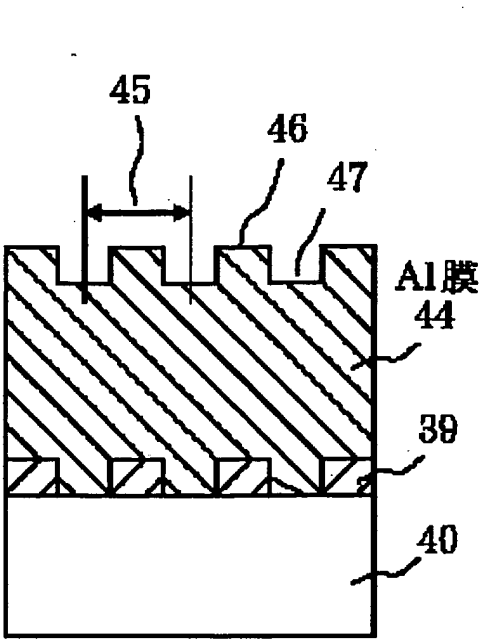
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Al膜
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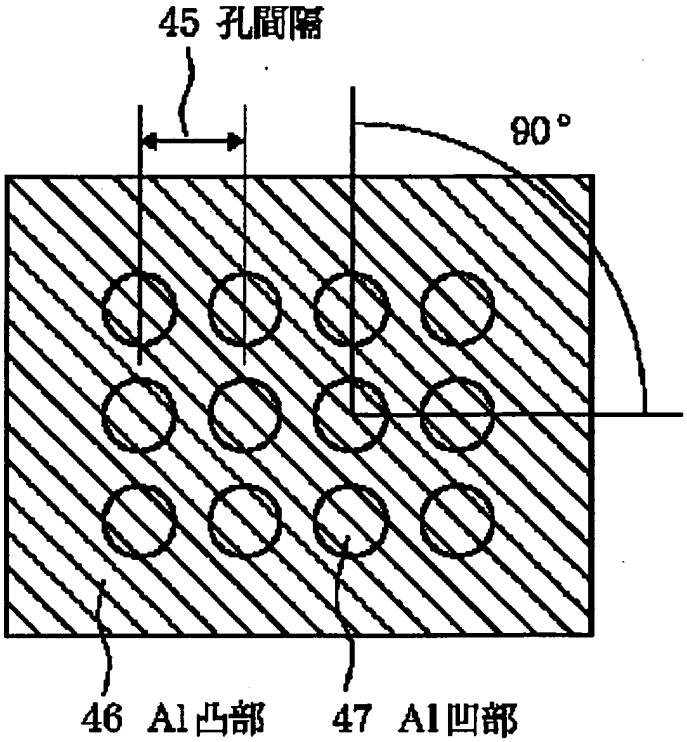
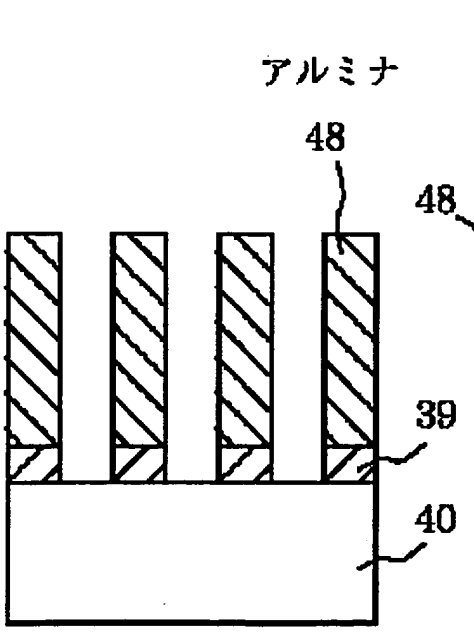
(4c)


45 孔間隔
90°
46 Al凸部
47 Al凹部

(4c')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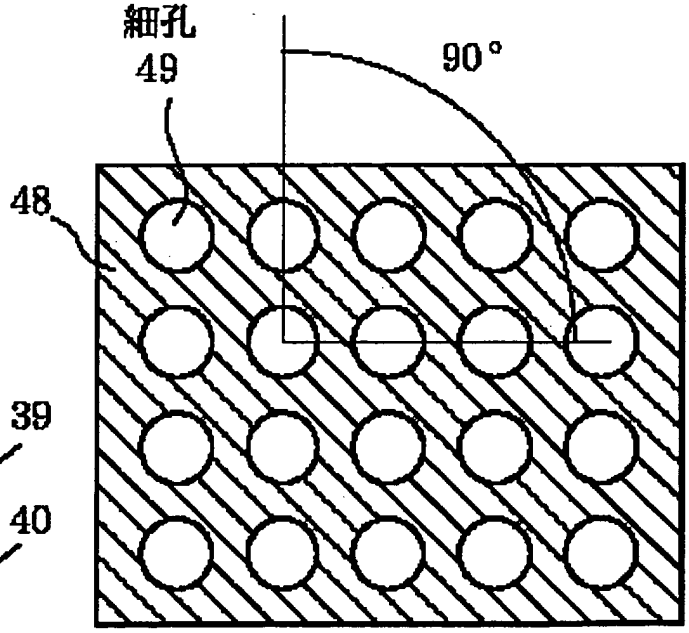
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90°
48

(4d')

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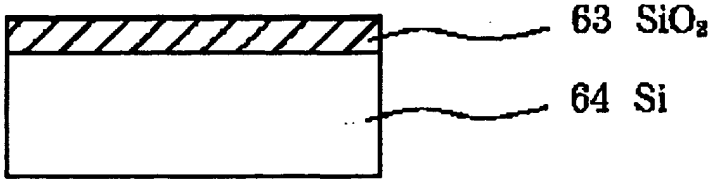

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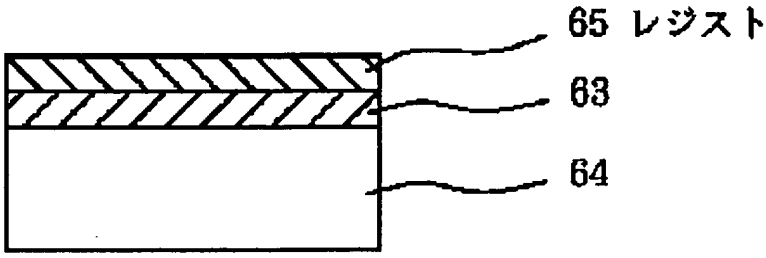

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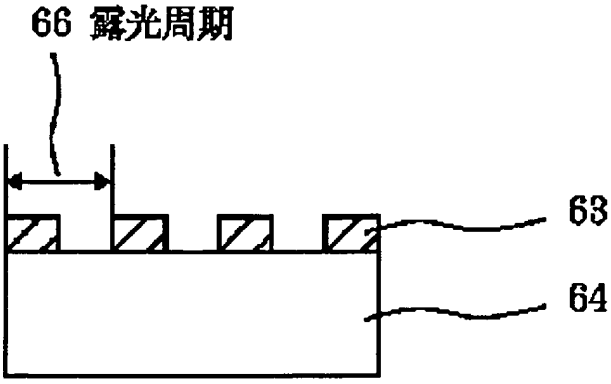

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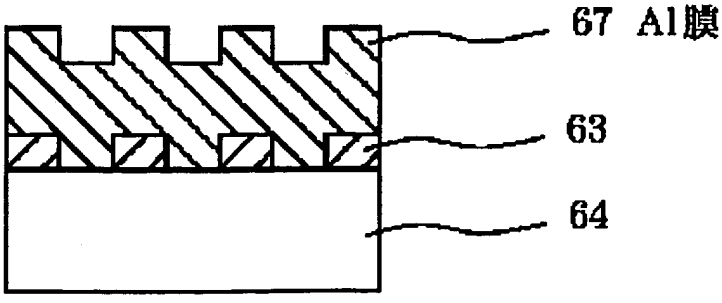

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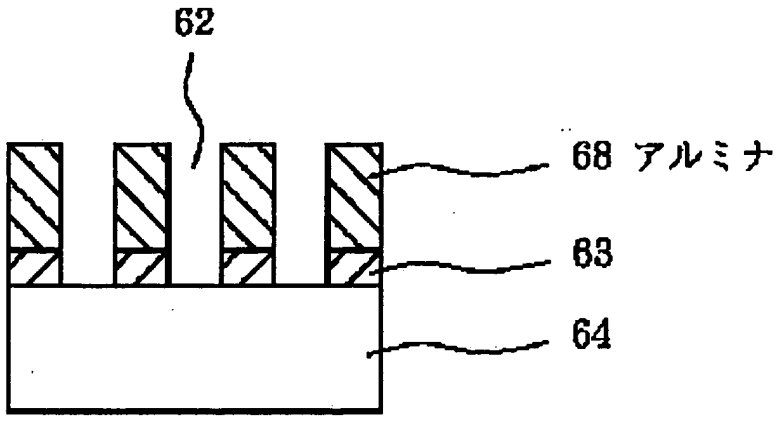

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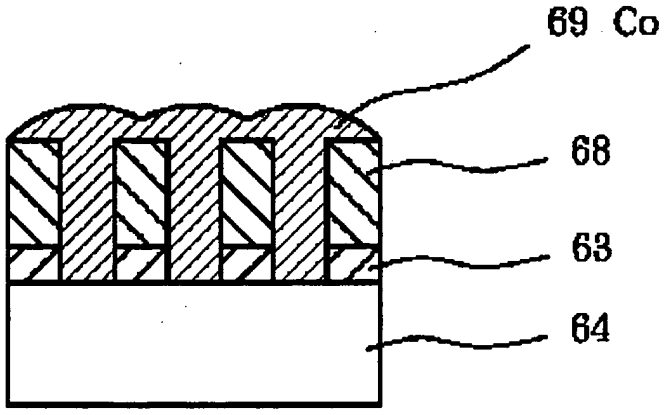

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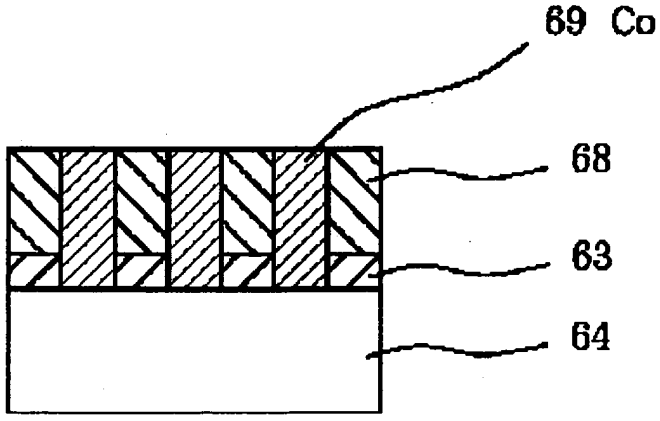

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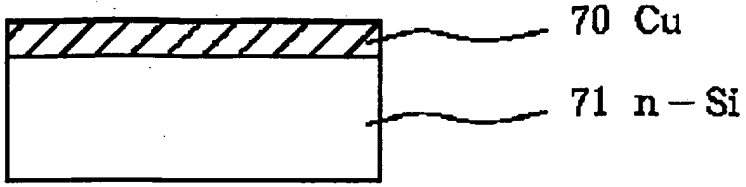

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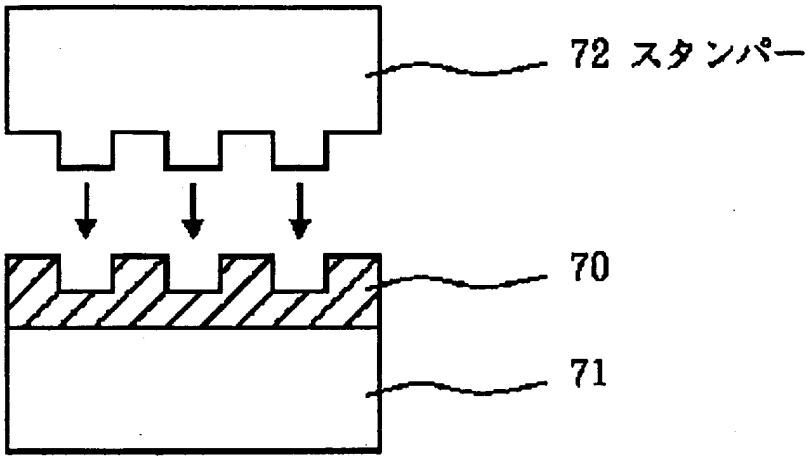

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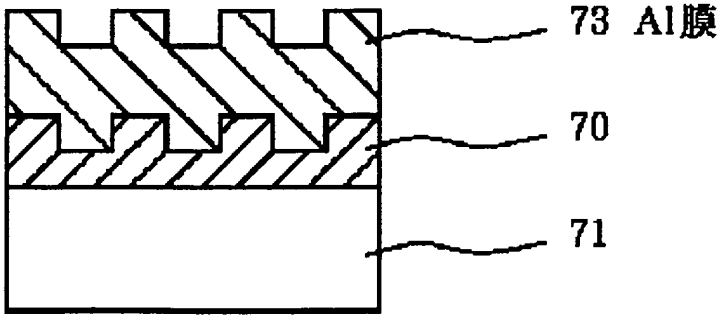

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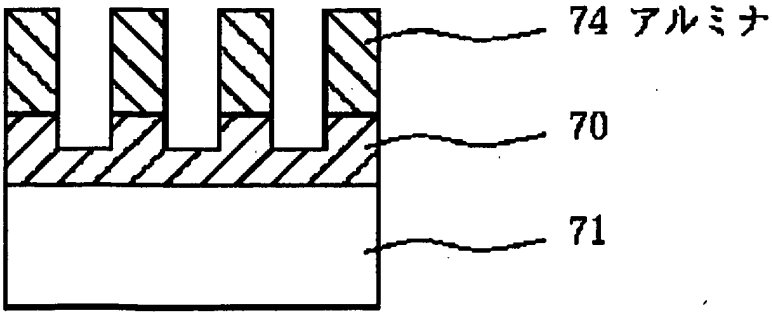

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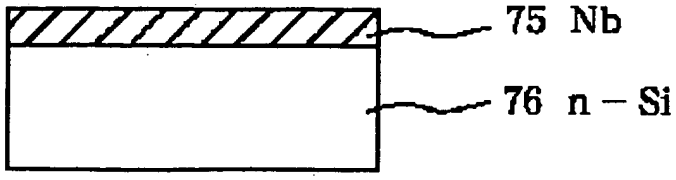

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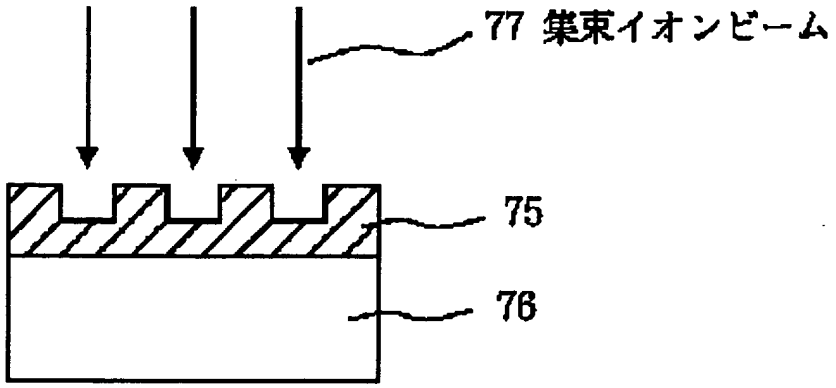

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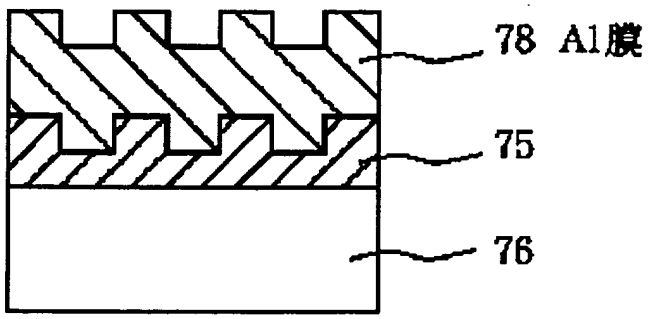

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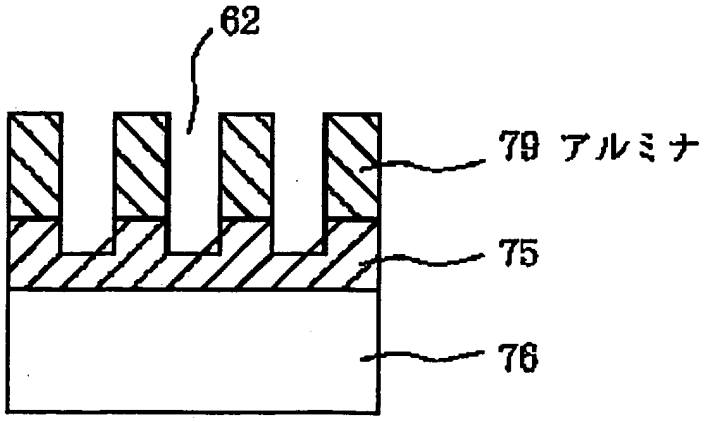
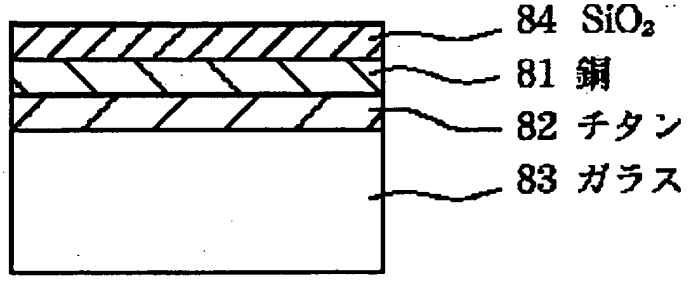
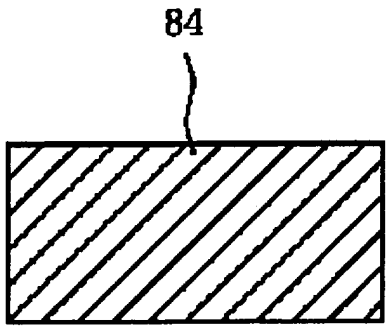



84 SiO_2
81 銅
82 チタン
83 ガラス

(9a)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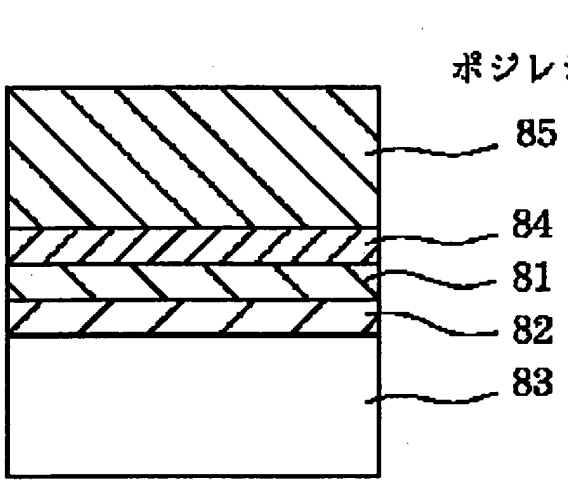
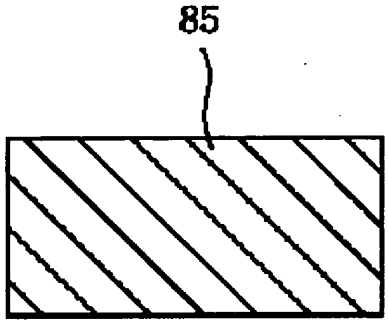
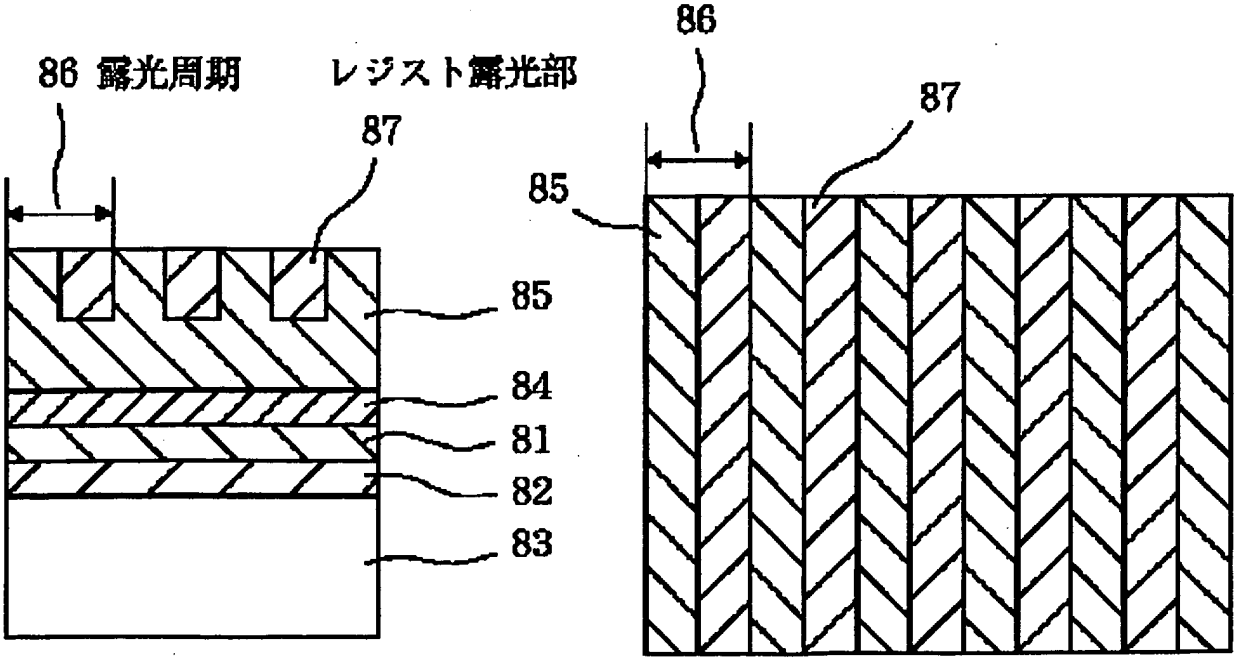
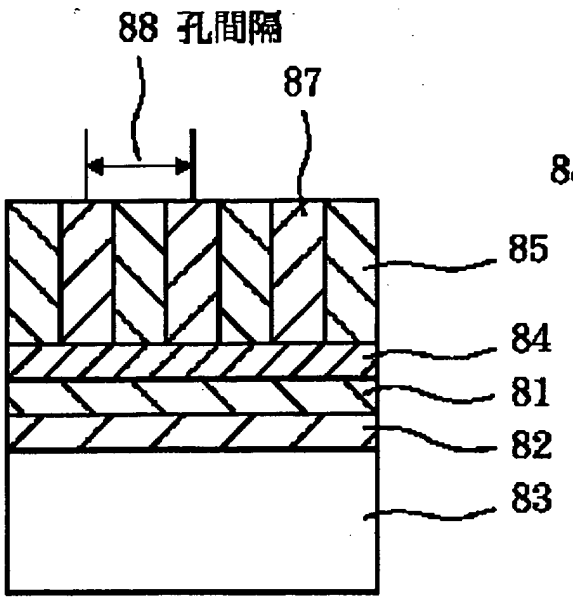

ポジレジスト
85
84
81
82
83

(9b)

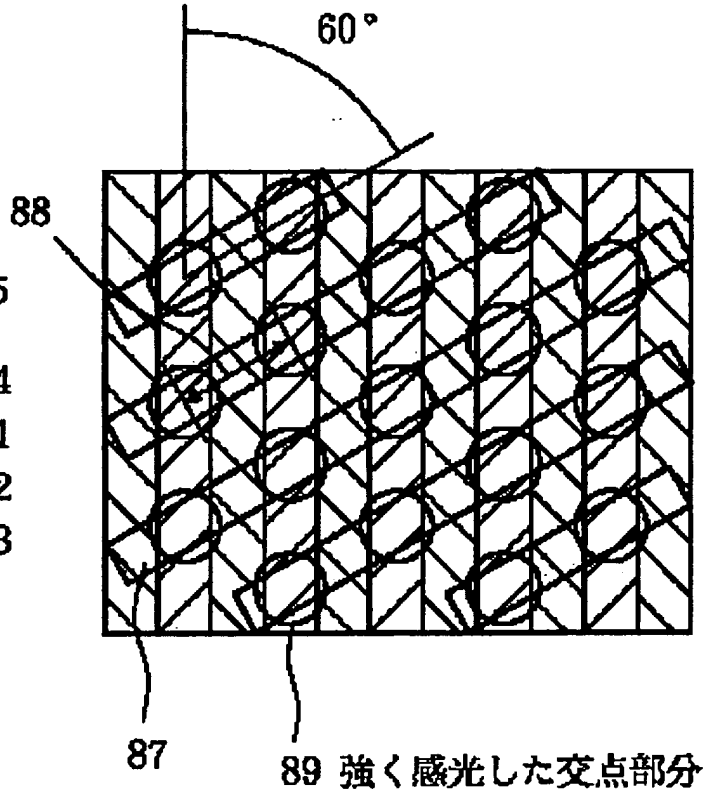

85

(9b')

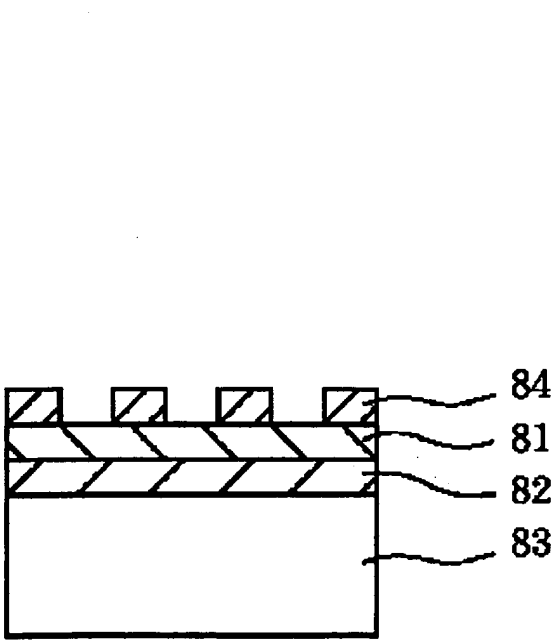

86 露光周期
レジスト露光部
87
85
84
81
82
83
86
87
85

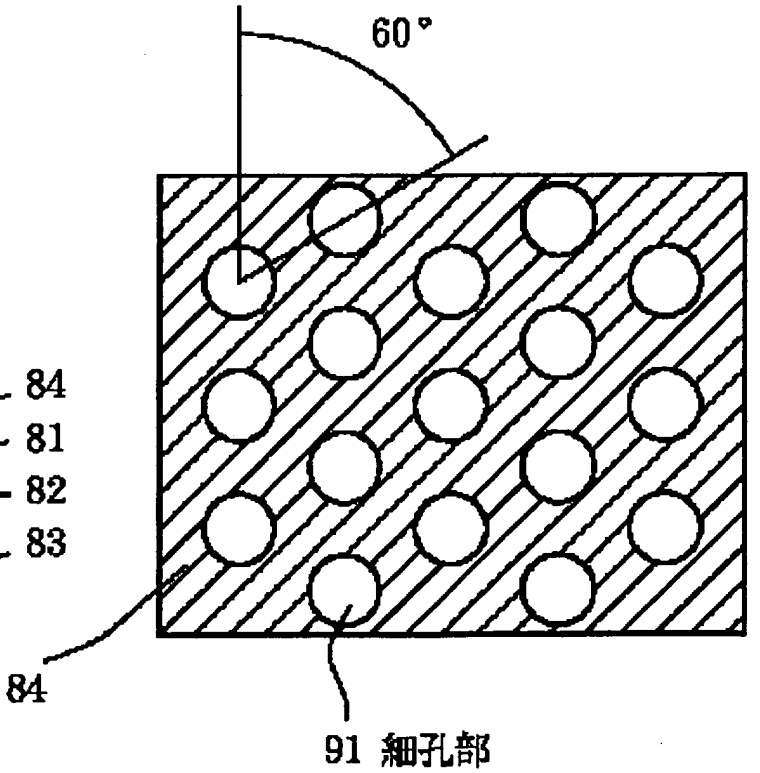

88 孔間隔
87
85
84
81
82
83

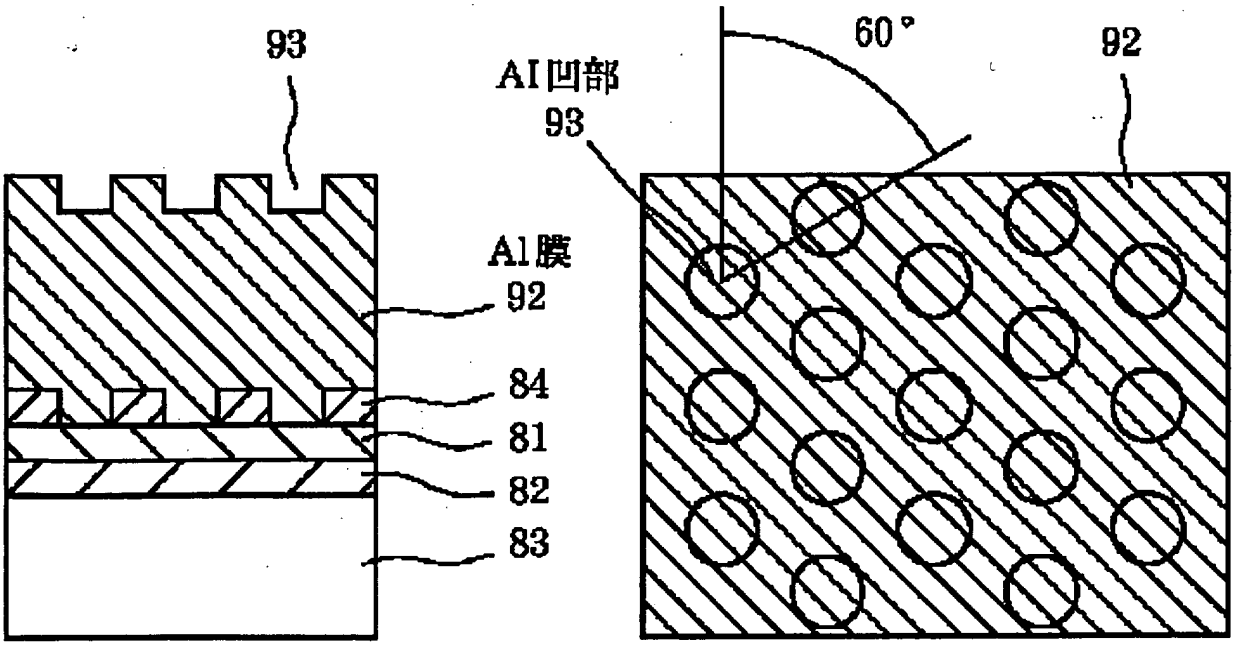
(9d)


60°
88
87
89 強く感光した交点部分

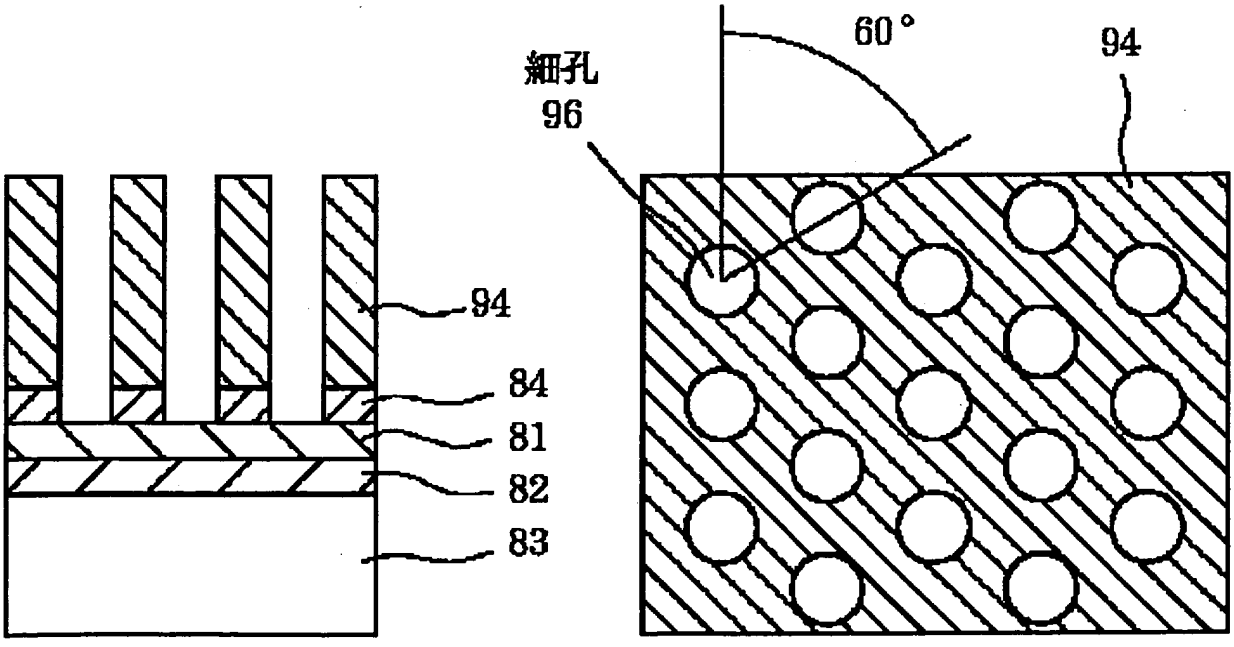
(9d')


84
81
82
83


60°
84
91 細孔部



(9f)　　(9f')



(9g)　　(9g')